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WITH

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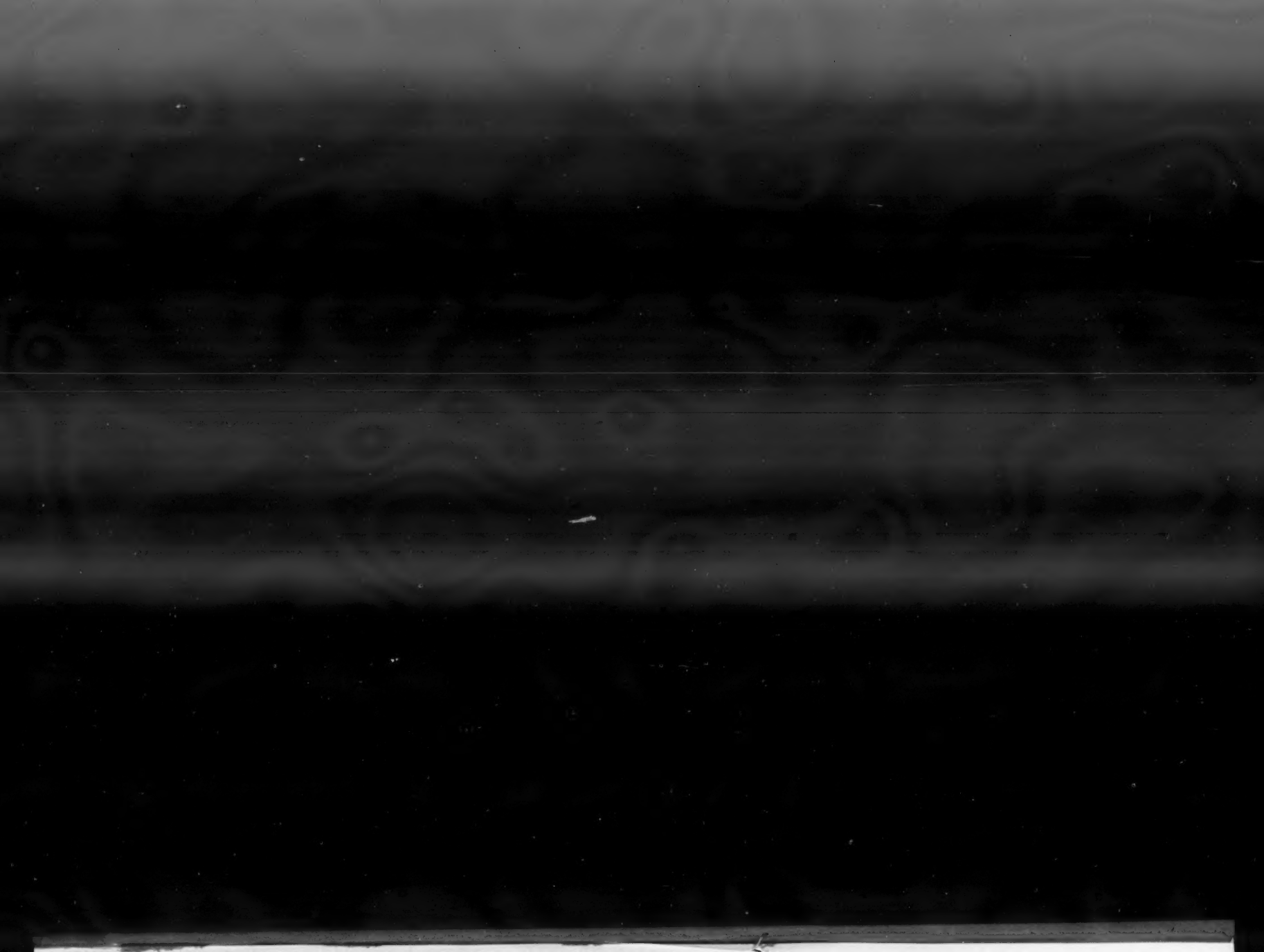

SURGERY, GYNECOLOGY AND OBSTETRICS

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THE PHYSIOLOGICAL TREATMENT OF BULLET AND SHELL WOUNDS OF THE PERIPHERAL NERVE-TRUNKS

BY HENRY H. M. LYLE, M.D., F.A.C.S., NEW YORK

Professor of Clinical Surgery, Columbia University, College of Physicians and Surgeons; Attending Surgeon, St. Luke's Hospital

THESE remarks are based on the study of cases observed while in charge of Hospital B., American Ambulance, Juilly, France. Hospital B., established and maintained by Mrs. Harry Payne Whitney, of New York, started with an equipment of one hundred and fifty beds which has now been increased to two hundred and thirty-five. The hospital is situated at Juilly, Seine et Marne, thirty-five miles behind the firing line, and receives its wounded from the sixth French army.

The contemporary literature of military surgery is rich in the operative and post-operative treatment of gunshot wounds of the peripheral nerves while the all-important preliminary treatment has received scant attention.

Primary suture of a divided nerve is the ideal treatment, but with a few exceptions this method is absolutely contra-indicated under the conditions existing in war time. The necessity of such an operation presupposes an anatomical division of the nerve. There is no sure method of immediately differentiating between anatomical and physiological blocking of nerve impulses. The symptoms are the same. This failure to recognize the impossibility of distinguishing between a division, a contusion, and a concussion of a nerve has lead to many unnecessary and harmful operations. On the other hand the element of time coupled with treatment based on physiological principles has cleared up many misleading symptoms and considerably reduced the number of cases requiring a secondary suture. Even if it were possible to make such a diagnosis, operation is absolutely contra-indicated as all projectile wounds are potentially infected, and to operate in the face of infection is to court disaster (Fig. 1). For these reasons it was our practice to treat all peripheral nerve lesions on an expectant plan, postponing nerve suture until the wounds were healed.

Many brilliant technical operations have given disappointing functional results. The operator besides contending with the uncertainties of nerve suture has had to correct accompanying deformities and to struggle against muscular degeneration. Such complications are in a large measure preventable and it is imperative to see that they do not occur. From the first, a suitable apparatus should be applied to relax the paralyzed muscles and protect them from strain, at the same time measures being instituted to preserve the nutrition of the muscles and maintain their excitability to electrical stimulation.

Immediately on the admission of a patient the following procedures were carried out:

1. A careful inspection of the soldier's clothes to determine the absence or presence of clothing in the wounds.

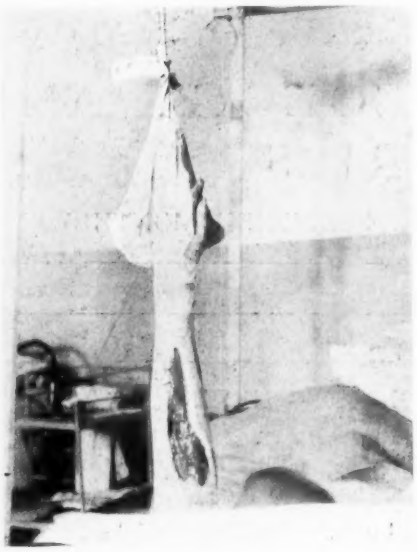

Fig. 1. Destruction of the elbow-joint by a bullet wound. Gas gangrene. Paralysis of median and musculospiral. This shows the impossibility of primary suture. Condition of wound two and a half months after reception.

2. Examination and dressing of the wound with a careful search for symptoms of nerve injury.

3. X-ray examination of every patient.

4. On the data derived from these procedures a course of treatment suitable to the individual case was instituted.

One must keep constantly in mind the extreme gravity of an injury to an important peripheral nerve, remembering that the unrelieved pressure of a bone splinter, an inflammatory exudate, or a jagged shell fragment may lead to irreparable damage. The prompt recognition and correct treatment of such conditions are imperative.

Shell fragments, shrapnel, etc., were removed by the Sutton localizing technique. This provided a simple, safe, and accurate means of removal and had the added advantage that it could be carried out under local anæsthesia. As a large percentage of the wounds were complicated by compound comminuted fractures it was necessary to provide for suitable fixation. In applying the splint two factors had to be considered:

(1) The immobilization of the bone. (2) The relaxation of the paralyzed muscles and their protection from the pull of their opponents. For example, in a fracture of the middle third of the humerus with injury to the musculospiral resulting in a drop wrist, some form of "cock-up" wrist splint had to be applied in addition to the splint for the humerus.

In the first two hundred and twenty-five cases there were thirty-three nerve lesions. Of these, twenty-nine were injuries to the peripheral nerves. The musculospiral was involved eight times, the ulnar six times, the median four, the external popliteal twice, the circumflex once, the musculocutaneous of the leg once, the sciatic once, the brachial plexus with sensory disturbances in the ulnar once. Besides these lesions of single nerves the following complex lesions were encountered: median and ulnar twice, musculospiral and median once, musculospiral and circumflex once. The circumflex in the complex case of circumflex and musculospiral was an indirect lesion, the wound of the musculospiral being two and one-half inches distant from the circumflex. Seven of the musculospiral lesions were complicated by compound fracture of the humerus (Figs. 2, 3, and 4), one by the lodgment of a shell fragment (Fig. 5). All were below the branch to the triceps. In two of the cases where the fractures were near the elbow the pressure symptoms on the nerve were greatly relieved by supinating the arm and placing the elbow in acute flexion (Figs. 3 and 4).

One case of supposed division was explored and the nerve found to be only contused. No operative work was attempted and under the routine treatment the patient made a rapid recovery.

One of the ulnar cases was the result of a stab wound received shortly before entrance to the hospital. Primary suture was performed with a good result.

Musculospiral injuries. The basic principle underlying the physiological treatment of this lesion is the use of an adjustable splint to hyperextend the hand and abduct the thumb, the arm being supinated. The hyperextension counteracts the continuous effect

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 2. Shows character of fracture accompanying the injury of musculospiral nerve.

Fig. 3. Bullet wound. Compound comminuted fracture of humerus with paralysis of musculospiral nerve. Acute flexion of the elbow-joint relieved the pressure on the nerve.

Fig. 4. Penetrating wound of arm, made by a trenching tool. Injury to musculospiral and ulna. Improving.

of gravity, relaxes the paralyzed extensors, and stretches the flexors, thus restoring the muscular balances and preventing the occurrence of a contracted drop wrist. The wrist is kept in this position of hyperextension until voluntary power is restored by nature alone, or nature aided by the surgeon. Physiological experimentation has taught us that the result of unrelieved, overstretched, muscular tissue is fatty degeneration, and a consequent loss of contractility. Clinical instances of such deformities are all too frequent, despite the teachings of Thomas, Jones, Tubby, and Tuffier. Strange as it may seem scarcely a textbook on neurology emphasizes the value of mechanical support to prevent contracture.

To support the wrist we used a flexible wire splint (Figs. 6 and 7). It was light, and any necessary adjustment in the angle of hyperextension could be readily made. The splint, extending from the finger tips to the

Fig. 5. Musculospiral injury with drop wrist caused by a small shell fragment.

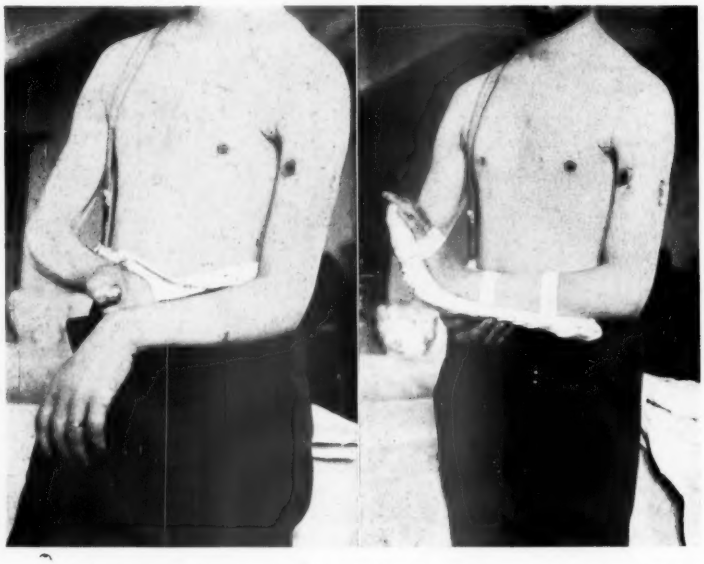

Fig. 6 (at left). Perforating bullet wound of the soft parts at the level of the deltoid. Note drop wrists.

Fig. 7. Same case as Fig. 6 treated by the hyperextension method. Shows a temporary splint used while the Tuffier splint is being made. There is an error in this picture as the splint is too long and there should be only one strap, that at the wrist.

Fig. 8. The Tuffier splint, palmar aspect. Note hyperextension of the wrist with abduction of the thumb. Fixation by laced wrist band.

lower third of the forearm, was secured at the tendinous portion of the wrist, care being taken to avoid pressure on the paralyzed muscles. The hand was kept in this position as long as there was any tension. The test for improvement was the ability of the patient

Fig. 9. Tuffier splint for drop wrist. *A*, Plaster cast of hand in the hyperextended position. *B*, Moulded aluminum splint, the surface that is applied to the palm. *C*, Position on cast showing hyperextension.

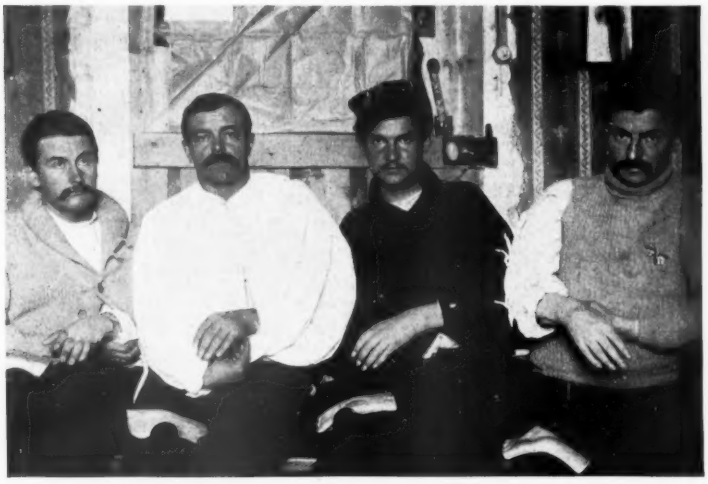

Fig. 10. Showing the improvement after using the Tuffier splint.

to lift his fingers from the splint. As the patient improved, the splint was shortened to the bases of the first phalanges. A better and more comfortable splint was called to our attention by Professor Tuffier, consulting surgeon to the French army. The object of the Tuffier splint (Figs. 8, 9, and 10) is not to immobilize the hand, but to render the hand useful. It is essentially an aluminum plate exactly molded to the hand, lined with chamois and kept in place by a lacing over the back of the wrist. The sense of support and comfort derived from this splint was so gratifying that we adopted it as our sta ndard.

The nutrition of the muscles was maintained by the use of warm starch baths, systematic massage, muscle kneading, and exercises applied by trained assistants. The value of massage and exercise is emphasized, for there is a great tendency to sit back and say "let electricity do it," but here we are not dealing with a simple nerve but with a nerve lesion complicated by comminuted bone, torn muscles, inflammatory exudate, etc., the whole tending to form obstinate adhesions. The galvanic current being a good stimulant to nutrition is of more value than the faradic, but compared with the other measures electricity plays but a minor part.

Ulnar injuries. The resulting muscular strain from a paralysis or a weakness of the flexor carpi ulnaris, half the profundus, and the interossei is overcome by spreading the fingers apart, flexing the first, extending the second and third phalanges, and adducting the thumb. This position can be readily maintained by an accurately molded, aluminum splint.

Median injuries. The resulting muscular strain from a weakness or paralysis of the flexor carpi, radialis, flexor sublimus, half the flexor profundus, and the pronators is overcome by strong flexion of the hand and fingers, abduction and flexion of the thumb, and slight rotation of the arm (Fig. 11).

Circumflex injuries. The paralysis of the deltoid is combated by abducting the arm.

Injury to the external popliteal and musculocutaneous. The foot is placed in a position of strong dorsal flexion and eversion (Figs. 12 and 13).

Complex nerve injuries. In complex nerve injuries each combination has to be worked out on physiological principles. For example, in lesions involving the musculospiral and median, a mid-position has to be assumed, but as gravity also plays a considerable part, a slight hyperextension of the wrist with strong flexion of the fingers is admissible.

Fig. 11.

Fig. 12.

Fig. 13.

Fig. 11. Bullet wound of the forearm. Pressure paralysis of median. Relieved by the extraction of the bullet.

Fig. 12. Gutter fracture of the head of the fibula. Paralysis of the external popliteal.

Fig. 13. Perforating wound of the left leg with a fracture of the fibula produced by a rifle ball. The musculospiral paralysis resulting from the injury is improving under treatment.

If the flexors of the forearm are paralyzed, tension can be relieved by flexing the arm at the elbow by means of a sling which draws the wrist toward the neck.

Pressure to the sciatic nerve with sensory and trophic disturbances of the leg. This case is cited to show the value of routine X-ray examination in nerve lesions. On September 10, 1914, the patient was wounded in the posterior aspect of the thigh, beneath the gluteal fold. Three days later fragments and portion of clothing were removed. After a slow convalescence he was sent again to the front. In February he developed obstinate ulcerations on the back of the calf and ankle. He was then sent to our hospital, the accompanying diagnosis being "trench disease or trophic ulcer?" On examination there was a loss of sensation over the area of ulceration. X-ray examination revealed the presence of a minute shell fragment beneath the original wound of the thigh. Dr. Sutton localized and removed the fragment which was found to be pressing on the sciatic nerve. The patient made a rapid recovery.

SUMMARY

1. Damage to an important peripheral nerve is an injury of extreme gravity.

2. Primary nerve suture is rarely indicated in war time.

3. Unrelieved, overstretched, muscular tissue leads to fatty degeneration and consequent loss of contractility.

4. A paralytic deformity with shortened muscle and limited joint movement, in the majority of cases, is the result of ignorance or neglect.

5. It is imperative, whether the nerve is divided or not, that the paralyzed muscles be relaxed and protected from strain by a suitable apparatus. Under no circumstacnes must this be deferred to the so-called after-treatment.

The postural prophylaxis begins with the reception of the wound and continues after the operation until voluntary motion is restored. A strict adherence to this vital orthopedic principle aids in the diagnosis, hastens recovery, prevents many distressing deformities, and will materially diminish the number of useless limbs.

6. This essential principle has not received the attention from the general profession which it deserves.

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OPERATIVE TREATMENT OF GUNSHOT INJURIES TO THE PERIPHERAL NERVES

By H. E. SCHIFFBAUER, M.D., F.A.C.S., Königsberg, Germany
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DURING the past fifteen months I have had a splendid opportunity to observe a large number of cases suffering from injuries to the peripheral nerves, in the clinic of Professor Friedrich in Königsberg, in different military hospitals in East Prussia, in the German Red Cross Hospital in Constantinople, and in Professor Dollinger's clinic in Budapest. Unfortunately I could not follow the cases that I operated on so as to enable me to give a definite report as to the results obtained. Therefore I will discuss only the indications for operation, the pathological conditions found, and the operative technique used.

INDICATIONS FOR OPERATIONS

Operation is indicated when the nerve is completely severed — a condition indicated by the absence of motor, sensory, trophic, and vasomotor function; when the motor paralysis is complete; when all muscles supplied by the nerve injured are completely paralyzed; when reaction to degeneration is present, the sensory disturbances usually corresponding to the area supplied by the nerve. If the injury is of long standing the sensory field may have diminished in size due to the collateral branches. Complete sensory inhibition in all qualities is not always found when the nerve is completely torn.

The diagnostic difficulty lies in the fact that the continuity of the nerve may be intact, notwithstanding the fact that complete motor and sensory paralysis exists. There are no pathognomonic signs which tell us if only the transmission of the nerve impulse is interfered with or if the continuity of the nerve has been destroyed. This applies to the first few months after the injury. Therefore, it is necessary to wait at least three months before a definite diagnosis that the nerve has been completely severed can be made.

There are cases in which only a portion of the muscles supplied by the nerve injured is affected and only a portion of the sensory field is disturbed, and in these cases after a short period of time a partial restoration of function takes place. If marked improvement does not take place within eight months, operation is indicated.

There is another class of cases; those of partial paralysis in which the muscles are only partially affected and in which the sensory area is slightly disturbed and there is a partial reaction to degeneration. These cases should be operated on only when intolerable pain exists which cannot be controlled by other means.

TIME OF OPERATION

Oppenheim (1) advises waiting at least three months in severe cases. Rothman (2) takes the extreme conservative point of view and advises waiting at least eight months. I favor early operation, that is as soon as the wound is completely healed and the danger of infection has subsided. In clean infantry wounds it is advisable to wait three to six weeks. In wounds that have been badly

infected I usually wait six to eight weeks after the wound is completely healed. The reasons for early operation are the following:

The earlier the operation is performed, the better are the anatomical relations maintained, the scar-tissue is present in smaller amount, it is soft and easily removed, the capillary oozing is diminished thus preventing the tendency to hæmatoma formation and the development of more scar-tissue.

If the nerve is compressed by callus or scar-tissue the longer the operation is delayed the more injury is done to the nerve.

The longer foreign bodies are present the more scar-tissue develops and the greater is the nerve destruction.

The longer the operation is delayed, the firmer are the muscular contractions and the greater the deformity in the joints.

The longer the muscle is paralytic the stronger is the contraction of the healthy muscles and the more marked is the fixation of the joint in the pathological position.

These contractures due to nerve lesions can be prevented by early operations.

Many trophic changes in the skin, muscles, bones, and joints can be prevented by early operation.

Severe pain which cannot be controlled by other means is always an indication for early operation.

In those cases in which it is impossible to perform an early operation, the paralytic muscles must receive mechanical therapeutic treatment and be kept in splints so as to maintain their proper position.

A great deal of time and expense is saved by early operation.

The only argument against early operation besides infection is that a positive diagnosis cannot be made and there is a question as to whether the function may not return without operation. From the many different reasons given above I cannot understand why the neurologist insists upon delaying the operation for five to eight months.

PATHOLOGICAL CHANGES FOUND

When the nerve is completely torn, the gap is filled with a dense homogenous mass of scar-tissue, the ends are retracted, knobby or spindle-form, and are often very difficult to recognize. Constricting bands may be seen about the irregular fragmented ends. These bands often explain the cause of the severe pain. However, I have seen cases of severe pain in which these bands were wanting.

When the nerve is only partially lacerated, the torn fibrils are retracted, embedded in a spindle-form mass of scar-tissue which may assume the form of the nerve or may be flat or form a definite constriction at the point of injury. In some cases the scars extend on both sides of the nerve, binding it to the surrounding tissue and giving it a flattened appearance.

The amount of scar-tissue present depends upon the type of injury and the severity of infection that has taken place; the greater the destruction of the muscle-tissue in the compound infected fractures, the more scar-tissue results.

Neuroma formation has occurred in all of the fragmented nerve ends.

I have found small metallic splinters, bone and muscle fragments in the injured nerves and incorporated in the scar-tissue about the lesions.

Frequently the fragmented nerve ends are found embedded in dense callus and between bone fragments. In one case of spiral fracture of the humerus, in the direction of the musculospiral groove, three months after the injury the central and the peripheral ends of the musculospiral nerve were found embedded in dense bone, the respective ends being separated six centimeters. In this case it is possible that in reduction of the fracture the ends of the nerve were caught between the ends of the bone and embedded in the bone callus.

Small hæmorrhage or exudate under the perineurium may cause a temporary inhibition of function.

I have seen two cases of multiple injury to the musculospiral nerves.

TECHNIQUE OF OPERATION

The important points in technique to secure perfect function are the accurate coaption of the normal nerve ends in their physiological, anatomical relation with an aseptic

wound healing without the formation of a hæmatoma; early passive and active motion; and massage, with the application of heat and electricity.

All operations were performed without the application of the Esmarch tourniquet. I have found that it is more difficult and time-consuming to control the capillary oozing when the Esmarch constriction is used. The wound must be left in a dry condition before closure. It is not advisable to apply a compression bandage over the wound to control the hæmorrhage, because the pressure over the nerve may injure the line of suture. The development of a hæmatoma is to be prevented. If the oozing cannot be controlled, a cigarette drain should be inserted for twenty-four hours. Hæmorrhage resulting from the cross section of one of the large nerves should be controlled by digital compression of the nerve. If this does not suffice, a fine point hæmostat should be carefully applied to the vessel and then given a few turns. Ligation is seldom necessary.

Through a long incision over the course of the nerve, with careful control of the bleeding, the central end of the healthy nerve is located, and, by sharp dissection, prepared toward the point of the injury. All scar-tissue is carefully removed and the nerve lifted from its bed and palpated. If the nerve has an abnormal appearance, I resort to Hofmeister's (3) diagnostic injection of a one-half per cent solution of novocaine to which one drop of suprarenin to ten centimeters has been added. The injection is made beneath the perineurium. It loosens the perineurium, and separates any septa that may have formed so that the fibrils are loosened from any constrictions that may exist. Sometimes constrictions are seen that can be split and the nerve assumes a uniform cylindrical form. If upon palpation abnormal resistance is felt, a diagnostic incision can be made into the suspected portion and the fibrils exposed for macroscopic examination, after which the perineurium is carefully sutured, and the nerve is placed in a new muscle-bed free from scar-tissue.

If the nerve ends are separated and embedded in a mass of scar-tissue which necessitates a resection of the nerve, I do not disturb the normal anatomical relation of the nerve until I have placed a fine silk guide-suture in the mid-line of the perineurium in the central and the peripheral ends some distance above and below the lesion. This guide-suture helps to approximate the nerve in its normal anatomical position. If we are not careful the motor fibers may be approximated to the sensory fibrils, and in this way delay the restoration of function. Care must be taken not to injure the intact muscular branches, for if we do function may return in the nerve that has been sutured, but another group of muscles may lose their function. I have seen a number of patients that have been made worse by the operation.

If electrical examination shows that a portion of the nerve is still intact careful dissection must be made so as not to injure the intact fibrils. The scar-tissue is excised, leaving the healthy portion of the nerve *in situ* and the resected ends approximated with fine perineural catgut sutures.

How much of the nerve should be resected? I usually make the first section with a thin, sharp knife (a Gillette razor blade held with forceps does very well) just a little beyond the junction of the scar with the healthy nerve. Usually some areas of scar-tissue are still to be seen in the healthy end. Millimeter sections are made until the nerve presents a normal histological appearance. A histological examination of a piece that was thought to be normal still showed the presence of scar-tissue, but in this case a good functional result was obtained. This shows that regeneration takes place if a small portion of scar-tissue remains.

The approximation of the ends so that they can be sutured without tension is often difficult. It can usually be brought about by manual manipulation of the nerve; that is, gradually stretching it by flexion of the joints and by luxation of the nerve from its normal course. In case of pseudo-arthrosis in the region of the injury, resection of the bone allows the ends of the nerves to be readily approximated. In a case of resection of the musculospiral nerve where a gap of 10 centimeters existed, Borchard (4) implanted the central and the peripheral ends, into the musculocutaneous.

In nine months the triceps and the supinator regained their function, the extensors were still paralytic and the abductor pollicis had slight functions. Hofmeister (3), independent of the work of Borchard, has done during the past year a large number of operations of nerve implantation. In some cases he has performed double and triple implantations. I had to resort to the nerve graft only once, in which case the central end of the ulnar was grafted into the median nerve in healthy tissue above the injury and the peripheral into the same nerve some distance below the injury. The healthy nerve was not injured through this procedure.

The nerves are sutured with fine catgut, grasping only the perineurium and applying six to ten sutures. In some cases where the tension is too great a stronger suture is applied through the substance of the nerve. I always try to avoid suturing through the substance of the nerve.

The question of how to protect the nerve after the suture has not been definitely decided. Fascia, fat, muscle, veins, and artificial organic tubes have been used for this purpose. Hofmeister (3) reports an interesting case. He made a circular anastomosis of the musculospiral nerve and covered the sutured line with a portion of a vein taken from the patient. There was no improvement after five months. On operating again he found the nerve in good anatomical relation. The place of suture was hardly recognizable, but the nerve had changed into a hard, round mass of fibrous tissue. On section of the nerve no fibrils were to be seen.

In my cases I have prepared a new bed, free from scar-tissue, from the surrounding muscles. It was often necessary to use a pedunculated muscular flap. In operating on the brachial plexus where sufficient muscle-tissue could not be had a fascial flap was used. The tissues which came in contact with the nerve were infiltrated with fibrolysin. It is questionable if fibrolysin will help to prevent the formation of new scar-tissue. Professor Tuby has had splendid results in preventing the recurrence of Dupuytren contraction in cases operated on.

The after-treatment consists in the removal of the splints that have been applied to keep the joint in extreme flexed condition, on the fourteenth to the eighteenth day, early passive and active motion, massage, and the application of heat and electricity.

PROGNOSIS

The longer the nerve course is broken, the slower regeneration takes place after suture.

The farther peripheral the nerve is injured the sooner function returns after suture.

The larger the nerve and the more centrally located the injury, the slower the return of the function.

I have seen function return in a sutured ulnar nerve just above the condyles in ten weeks. As a rule no marked changes take place until the lapse of three to six months.

The neurologist to the Dollinger clinic showed me a case of complete laceration of the musculospiral nerve with a typical wrist drop and complete reaction to degeneration, which had been operated upon three weeks previously, resection of the nerve with suture being performed. The patient stated that he could extend his fingers two weeks after the operation, whereas before the operation he said that he could not move his wrist in the extended position. The neurologist verified his statement. He showed me the history of the X-ray examination before the operation and demonstrated the change that had taken place since the operation. He says that it is the first case that he has seen recover so promptly after the operation and is at a loss how to explain the sudden change.

REFERENCE

1. Berl. Klin., 1915, No. 2.
2. Berl. Klin., 1915, No. 48.
3. Beitr. klin. Chir., xcvi, No. 3.
4. Deutsch. Ztschr. f. Chir., 1907, lxxxvii.

MEDICAL ASPECTS OF THE WAR[1]

By ROGER I. LEE, M.D., Boston

THE observations upon which my remarks are based were made during the past summer. The second Harvard unit, of which I was a member, had charge of a British Base Hospital of 1040 beds at Camiers, Northern France. Our patients were with rare exceptions British soldiers. We had no commissioned officers for patients. Our hospital was one of a group of similar base hospitals in the vicinity. Consequently, it has been possible to confirm my own personal data with similar observations made by other men in these other hospitals. While I saw something of the London Hospitals, I saw none of the French Hospitals. My remarks must therefore be limited to the conditions observed among the British Expeditionary Force in France. I purposely omit from discussion the ordinary cases of illness which are common both in civil and military practice. Our hospital which was a general hospital had a goodly proportion of patients whose illnesses could in no way be attributed to the war.

Hospital service in the war zone always implies the treatment of the wounded. Yet the experience in previous wars has been quite otherwise. In nearly all wars the so-called medical cases have largely outnumbered the surgical cases. This, of course, has been largely due to the prevalence of typhoid fever and the various dysenteries. In our Spanish American War the records show that 25 per cent of all soldiers in encampments had typhoid fever. Consequently the very large majority of army surgeons confined their work exclusively to the care of typhoid fever. In the present war, due to many causes but more particularly to the advance in sanitary science, the records seem to show more surgical cases than medical cases. In the hospital assigned to the second Harvard unit the 1040 beds were roughly divided into two divisions; a medical and a surgical division. The medical cases comprised one-third to one-half of all the cases. During my stay there I did not see a single certain case of typhoid fever. There was one doubtful case. From the reports of other hospitals it was evident that typhoid fever was a rarity, which speaks well for the sanitary arrangements of the British Army. In one group of 55,000 troops, 58 had typhoid fever with 2 deaths. In our Spanish-American War a similar group would have shown probably over 10,000 cases. Furthermore, the fact that typhoid fever did exist to a considerable extent in the civil population showed that typhoid fever was an ever constant menace.

Perhaps as important a factor in the reduction of typhoid fever as sanitary inspection was the preventive inoculations. The British fairly generally use two inoculations in place of the three inoculations which have shown such remarkable results in our army service. On account of the tremendous pressure in raising the large voluntary army the anti-typhoid inoculations have not been systematically administered in every instance. Some men received no inoculations and others only one and still others two at improper intervals. Most of the cases of typhoid seem to occur in those who had not been inoculated or in those who had had only one injection.

Para-typhoid fever occurred more commonly than typhoid fever but was still unusual. The fact of its occurrence demonstrates that the sanitary measures are not yet perfect, and more important still that the typhoid inoculations play a large rôle in keeping down the typhoid fever. Under the conditions the diagnosis of para-typhoid fever was difficult. It is possible that a considerable number of unexplained fevers with negative blood cultures when seen at the base hospital, and negative serum reactions to the two common types, could have been demonstrated to show some form of the para-typhoid group by complete bacteriological examinations of the stools.

Diarrhœas were surprisingly infrequent,

[1] Read before the Clinical Congress of Surgeons of North America, Boston, October 25-29, 1915.

perhaps not more frequent than in a similar group in civil life. There was one case of bacillary dysentery which was demonstrated by the mobile laboratory near the front.

While most infectious diseases did not come to our hospital, I saw elsewhere the usual run of measles, mumps, scarlet fever, and venereal diseases that are endemic in any community life. Scabies which had been rampant earlier in the war was still frequent.

There was one very surprising aspect with regard to infections of the respiratory tract. During my stay through the summer months the ordinary infections of the upper air passages were distinctly rare. Tonsillitis was not seen. Acute bronchitis existed nearly always as an exacerbation of a chronic bronchitis. Pneumonia occurred both in the form of lobar and bronchopneumonia, giving the usual classical signs but in our experience without sputum. The absence of sputum prevented our determining the infecting organism. The course of the pneumonias was not typical of the frank infections with the pneumococcus with sudden onset and defeverescence by crisis.

There were many cases of so-called "rheumatism." I use the term "rheumatism" advisedly because these cases comprised a very unusual group. We had a few cases of typical arthritis but always in patients who had had previous rheumatic fever. The vast bulk of the rheumatic group was essentially similar. The onset was more or less abrupt with fever which varied in intensity. Shortly after the onset there developed considerable pain in the muscles, chiefly in the legs and back. This pain and muscular tenderness persisted after the fever subsided. There was no history of a preliminary sore-throat or coryza or of any focal infection to suggest the point of entrance. In a small group carefully analyzed by Dr. F. W. Snow no common etiological factor such as exposure, frost-bite, etc., could be demonstrated. Nevertheless these cases were definitely infectious. The course of this condition was a few weeks. We felt that the salicylates cut short the temperature but had no effect upon the pain. None of the various remedial measures seemed to control the pain which was often so severe as to suggest a neuritis. However, there was never tenderness over nerve-trunks or modified reflexes. Cardiac complications were noted in no case. The condition was well recognized and went under the popular name of "trench rheumatism." It seemed to be a true infectious myositis of a type not seen in civil practice. How much exposure and posture had to do with the localizing the symptoms in the legs and back was uncertain.

Another new clinical entity of which we had a considerable number of cases in common with other hospitals, and of which I saw some cases from the Dardanelles in the London hospitals, was the so-called "trench nephritis." This condition was of all grades and severity. A typical case might be described as follows: The onset was sudden and often could be dated to a particular hour in the day. Fever, general malaise, bloody urine, and œdema, all appeared simultaneously. The duration of the fever varied from a few days to a few weeks. With the subsidence of the fever the blood and œdema also usually subsided. There seemed to be a period in which the patient felt perfectly well but passed urine with 1 to 2 per cent of albumin, but with no cellular elements. The terminal stage was represented by small traces of albumin but considerable amounts of pus in the urine. Bacteriological investigations were negative. Some of the patients had coma. Our experience in common with that of the other hospitals showed that the blood-pressure never was high; our highest recorded systolic blood-pressure among our cases was 170 in a comatose individual. Recovery was the rule and occurred without exception in our cases. The condition seemed unquestionably an infection, a true acute nephritis of unusual type in that it was apparently very severe at first but remarkably rapid in its convalescence.

Another group of cases which included nearly half of the medical cases was composed of the functional nervous disturbances. A certain proportion of them was the functional disturbances seen in civil life. For example there were the functional gastric disturbances which, however, seemed fairly constantly

associated with bad teeth. Cardiac neurosis is common enough in civil life and is seen in many forms. In our cases of cardiac neurosis, however, we found practically only one type. This occurred at all ages, although perhaps more common in the men over thirty. The type of occupation previous to entrance to the army made no difference. The symptoms varied in severity but were essentially always the same. The patient complained of fairly constant tachycardia with palpitation, dyspnœa and cardiac pain on exertion, never œdema. On examination the heart was of normal size, rarely slightly enlarged; the sounds were unusually sharp and slapping, especially the first sound at the apex. There was no accentuation of the pulmonic second. The blood-pressure was normal. The pulse rate varied between 80 and 140. There was no particular change after exercise. In these cases there were increased reflexes and the evidences of vasomotor instability such as perspiration, congestion of the hands, etc. No other evidence of thyrotoxicosis was apparent. While some of these cases improved somewhat, most of them under observation of several weeks remained essentially the same. In some instances rest in bed, in others cardiac tonics such as digitalis were tried but without benefit. While the ultimate prognosis was probably good the immediate prognosis for weeks and apparently for months seemed bad. The majority of these men were incapacitated for sustained hard labor.

Under the general heading of "shock," a very poor term which we were compelled to use for want of a better, was classified a large variety of functional disturbances. In these cases as a rule there was a history of some definite etiological factor; for example, some of these men had been gassed but did not suffer particularly from the affect of the gas itself. A more common story was that a large high explosive shell had exploded within a few yards and very likely killed or maimed some of the patient's comrades. The patient himself was not even scratched. Another common etiological factor of this so-called "shock" was being buried. As a rule the soldiers were not much affected by being buried by the dirt thrown up by an explosive shell provided they did not lose consciousness or have to be dug out. If they lost consciousness and had to be dug out the usual result was some form of shock. A certain number of cases of shock, chiefly in the younger men, seemed to be due to the summation of repeated small insults to the nervous system such as a prolonged artillery fire or the prolonged wear and tear of life in the trenches rather than to any single incident.

This so-called shock manifested itself in various ways. Some of the patients were completely aphonic. These usually recovered their speech spontaneously in one to three days without particular treatment. Others developed very pronounced stammering. Those cases seemed more obstinate and while they improved considerably, nevertheless they were not completely recovered by the time that they were physically able to take up their work. Generalized tremors were fairly common. Some interesting cases of unilateral tremor with diminished reflexes on the affected side were seen. Other cases could not describe their symptoms except by saying that they felt themselves "nervously done up" and that they were incapable of concentrated or sustained effort. Others described curious waves of terror that swept over them. In these latter groups of cases terrifying dreams and nightmares were common. One unusually courageous corporal had been shocked by a shell. He felt perfectly well and could stand the noise of all other explosives but the peculiar noise of a shell put him in a panic. It was remarkable to note that it affected the seasoned veterans of previous wars just as much as the recent volunteers. It was also interesting that in general the soldiers bore their wounds not only with fortitude but with equanimity. Apparently their nervous systems were adjusted to wounds by previous contemplation of the probability of being wounded. Yet the soldier without a scratch the same distance from the exploding shell as his wounded comrade suffered from shock, while the wounded soldier had his wound but no shock.

PECULIAR INFLAMMATIONS OF THE ILIAC FOSSA, FOLLOWING SIMPLE EPIDIDYMITIS

Remarks on the Anatomy of the Lymphatics

By P. S. CAMPICHE, M.D., M.R.C.S. (Eng.), F.A.C.S., San Francisco

THE object of the present paper is to discuss the origin of some obscure inflammations in the iliac fossa to which surgeons and urologists have paid but little attention so far as I can ascertain.

Here are the histories of two of my cases:

Case 1. The patient, 33 years old, has always been in excellent health; he had gonorrhœa three years previous. On November 5, 1913, while lifting a heavy barrel, he felt a sharp pain in the left groin. I saw him the next day and found an indistinct soft swelling along the left spermatic cord, which I diagnosed as a hæmatoma of the cord; it disappeared in about two weeks, a point interesting to note in view of the predisposition often given to tuberculosis by a trauma. The left testicle and epididymis were normal at that time.

On December 31 (i.e. seven weeks later) the patient came to see me again, complaining of a slight pain in his left testicle. On examination I found a hard and tender nodule, the size of a small hazelnut, in the globus minor of the left epididymis. In the middle of January that nodule attained the size of a large hazelnut and was quite painful. At the same time a rounded swelling the size of small hen's egg was noticed in the left iliac fossa; it was oblong in shape, parallel to the external iliac artery and just at the inner side of that vessel; the lower pole of the ovoid just reached Poupart's ligament and I thought that some deep fluctuation was present.

On January 20, a consultation was held with another surgeon who had the blood examined, found a positive Wassermann and persuaded the patient to accept a treatment with salvarsan. At the same time the swelling in the iliac fossa was aspirated at a point near the external iliac artery above Poupart's ligament, and about 10 ccm. of pus was withdrawn and saved for injection into a guinea pig. The urine was normal; the prostate was enlarged and tender and contained two or three indurations in the left lobe of the gland.

On February 10 there was no change in the condition of the epididymis; the lowest part of the vas deferens showed several typical spindle-shaped swellings, but the rest of the duct was not altered. There was a large abscess in the left iliac fossa; about 250 ccm. of thick pus was withdrawn by aspiration and about 50 cc. of iodoform glycerin injected into the cavity.

On March 8 the pathologist who had examined the guinea pig reported the case as one of tuberculosis, and I persuaded the patient to submit to the operation of epididymectomy, but at the same time I strongly opposed any exploratory incision in the iliac fossa, as had been suggested to him by another surgeon.

On March 20 I performed epididymectomy. The wound healed by first intention and the patient left the hospital on the ninth day. The abscess in the iliac fossa was aspirated at the same time and again a large quantity of pus was withdrawn. The abscess filled again, but more slowly, and when aspirated for the last time on April 30, only 20 ccm. of pus were obtained. A swelling persisted for some time high in the iliac fossa, just inside of the external iliac artery, and then disappeared completely. Since that time he has been in excellent health; there is hardly any atrophy of the testicle; the urine is normal; the prostate shows two small fibrous nodules on the left side but is no more enlarged. Fifteen months have elapsed since the operation and so far nothing suspicious has developed in the right testicle.

This rare coincidence of a simple tuberculous epididymitis, with a large tuberculous abscess of the iliac fossa in the same side, will be discussed further on.

Case 2. A young man 27 years old came to see me on April 6, 1915, with an acute gonorrhœal epididymitis of enormous size, but the epididymis was nowhere adherent to the scrotum, and the vas deferens was only moderately swollen. The patient was put to bed and treated with compresses. A week later, on April 14, the epididymis was still quite large but not so tender as before. The patient complained of a pain in the left iliac fossa but I could find nothing there. On April 22 I saw him again. The epididymis was still very large; high in the iliac fossa, exactly on the external iliac artery, there was a swelling the size of a small hen's egg, with irregular surface and bosses, tender on pressure, lying deep in the iliac fossa. The temperature was 101°. I suspected a lymphadenitis, and fearing that an abscess might form there I kept the patient in bed and under observation. There were no peritoneal symptoms, and by and by the swelling decreased spontaneously. I saw him last on May 25, 1915; there was still some thickening just inside of the external iliac artery, but it was hardly noticeable. By that time the epididymis had resumed its normal size and shape and all that could be felt was a small hard scar in the globus minor.

Interpretation of the findings. In the classics on surgery and genito-urinary diseases, little is found about inflammations in the iliac fossa following simple epididymitis.

Casper[1] says that in gonorrhœal epididymitis and deferentitis, extraperitoneal suppurations may occur in the iliac fossa; if the condition is attended by high fever, chills, etc., he recommends the incision of the abscess through the inguinal canal in order to prevent peritonitis, but he asserts that often the swelling will disappear spontaneously without causing any alarm. He evidently assumes that the inflammation of the vas deferens invades the tissues of the fossa iliaca simply by continuity. This view does not appear satisfactory in our two cases: first, in both instances the vas deferens seemed very little involved above the testicle; second, the abscess and the swelling observed were not at all at the point where the vas deferens crosses the iliac fossa to plunge into the pelvis, but distinctly higher, just inside of the external iliac artery; so I thought it would have to be accounted for in some other way and asked myself if the explanation could not be found in the anatomy of the lymphatics.

For our knowledge of the lymphatics we surgeons rely almost entirely on the anatomists, and it has been an axiom in all standard books on the subject since Sappey, that the lymphatics of the testicle and epididymis all go to the lumbar or pre-aortic lymph-nodes. This view is still held by such anatomists as Bardeleben (Bartels) 1909, Cunningham (1913), Quain (1914), Morris and Jackson (1914), Piersol, Gray and others. All agree that the lymphatics of the testicle and epididymis go to the lumbar lymph-nodes, and the lymphatics of the vas deferens and seminal vesicles to the external iliac (or retrocrural) and to the hypogastric lymph-glands.

Horowitz and Zeissl[2] working in the laboratory of Professor Toldt in Vienna in 1890, undertook a very close study of the lymphatics of the testicle; by injecting the inner aspect of this organ, they discovered a lymphatic vessel which follows the spermatic cord through the inguinal canal and then empties itself not into the lumbar lymph-nodes but into a lymph-gland situated in the iliac fossa, on the external iliac vein, below the crossing of the ureter.

Most[3] and Jamieson and Dobson,[4] seem to accept the observation of Horowitz and Zeissl as correct. Spalteholz (quoted by Hinman) in his atlas, pictures some lymph-channels going from the testicle to an external lymph-node.

Hinman[5] in his paper on tumors of the testicle says: "Not infrequently a gland is found in the region where the ureter crosses the iliac," and he insists that this somewhat secondary gland should also be removed along with the main lumbar and pre-aortic groups in radical operations for malignant growths of the testicle.

Cunéo,[6] in 1912, states that most lymphatics of the testicle go to the lumbar and pre-aortic lymph-nodes lying from the renal pedicle down to the bifurcation of the aorta, and in front of the vena cava; he made a special study of the new vessel described by Zeissl and Horowitz, as going to the external iliac glands, and he was able to inject it in ten cadavers so that he considers it as constant.

Testut and Jacob,[7] in their topographical anatomy (vol. 2, Fig. 454), assert that the lymphatic gland of Horowitz and Zeissl lies in the iliac fossa immediately inside the external iliac artery on the external iliac vein, below the crossing of the ureter, and that it receives a part of the lymphatics of the testicle.

So that we are forced to admit with the best modern authorities on the subject, that a part of the lymphatics of the testicle do not go to the lumbar lymph-nodes, but do go to the so-called gland of Zeissl and Horowitz belonging to the external iliac group.

We feel certain that our two clinical observations corroborate this view of the anatomists; in our first case the rounded

[1] Casper and Bonney. Genito-Urinary Diseases. 1909.

[2] Horowitz and Zeissl. Wien. med. Presse, xxxviii, 761; Wien. klin. Wchnschr., 1890, p. 338.

[3] Most. On lymphatics of the testicle. Arch. f. Anat. u. Entwick., 1899, p. 113.

[4] Jamieson and Dobson. Lymphatics of the testicle. Lancet, Lond., 1910, i, 493.

[5] Hinman. Tumors of the testicle. J. Am. M. Ass., 1914, December 5.

[6] Poirier and Cunéo. The Lymphatics. 1912.

[7] Testut et Jacob. Traité d'anatomie topographique, 1914.

swelling appeared at a point on the external iliac artery high above the inguinal region and, after suppuration was established, worked its way gradually downward toward Poupart's ligament. There was no sign of pelvic or spinal tuberculosis in this case, and the rapid cure effected by only four treatments by aspiration speaks against the presence of a bony focus which, it seems to us, would have kept up the suppuration a longer time.

In the second case the irregular and undulated surface of the swelling high in the iliac fossa strongly reminded us of similar glandular inflammations in the neck. As to such lesion being due to the action of the gonococcus (possibly with mixed infections?), the urologists seem to regard this as quite possible. Casper (*loc. cit.*) mentions suppurations in the iliac fossa after gonorrhœal epididymitis, and Luys[1] says that gonorrhœal urethritis may cause a swelling and even a suppuration of the inguinal lymph-glands. Grosz[2] writing on gonorrhœal deferentitis, says that "in cases of severe epididymitis the lymphatic vessel of Horowitz and Zeissl brings the infection into the external iliac glands. He has seen such inflammations ending sometimes in retroperitoneal suppurations; and in a few cases this has even resulted in peritonitis, as was proved by nine cases that came to autopsy."

The point to be remembered by the surgeon is that a part of the lymphatic channels of the testicle empty into the external iliac glands, and this explains the presence of certain inflammatory swellings and even abscesses in the iliac fossa after simple epididymitis (tuberculous or gonorrhœal) without any involvement of the scrotum.

If such trouble should appear in the right iliac fossa some time after an acute epididymitis, the surgeon will do well to be on his guard before making the diagnosis of appendicitis. If signs of suppuration are present, he will have to keep in mind the fact that the trouble is extraperitoneal and will have to plan his intervention accordingly. At the same time he must not wait until the pus has perforated into the peritoneal cavity.

He will also not trouble himself with the possibility of omental inflammation (as I did in one case) if he knows that the iliac swelling is consequent upon a gonorrhœal epididymitis.

If a large abscess of the iliac fossa should form in a man recently suffering from a simple tuberculous epididymitis, the surgeon will know that a better prognosis can be given here than if the source of the abscess were a tuberculous caries of the pelvis or of a vertebra.

Lastly, for those who believe in removing the tributary lymph-nodes in malignant growths of the testicle, it will be just as essential to remove the external iliac group as the lumbar and pre-aortic lymph-glands.

[1] G. Luys. Traite de la Blennorrhagie. 1912.

[2] Grosz in Handbuch der Geschlechts-krankheiten. By Finger, Jadassohn, Ehrmann, Grosz, Vol. ii, p. 7.

THE OPERATIVE TREATMENT OF VARICOSE VEINS AND ULCERS, BASED UPON A CLASSIFICATION OF THESE LESIONS

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VARICOSE veins and their attendant ulcers have long offered and may continue to offer a fruitful field for surgical failures, and this not so much from the lack of effective weapons in the surgeon's armamentarium as from his failure to choose his weapon according to the strength of his opponent. The ligation operation of Trendelenburg (1), the multiple percutaneous ligations of Schede (2) and Kuzmik (3), the full dissection of Madelung (4), and the spiral cut of Rindfleisch (5), to mention a number of typical procedures, are methods of attack appropriate in varying degree to varix of the legs. In how far available or useful in a given case any one of them may be can be determined only by an exact knowledge of the circulatory abnormality which is present, and it is reasonable, therefore, to consider whether varicose veins can be effectively divided for purposes of diagnosis and treatment into a number of groups, typical and easy of recognition.

NORMAL ANATOMY AND PHYSIOLOGY

The recognition and classification of this abnormal circulatory condition requires a consideration of the normal venous return from the lower extremities. The blood which is to travel from the feet to the heart must rise, when the individual is erect, some four or more feet. The veins of the legs which conduct this flow are furnished with a considerable number of bicuspid valves, so set as to allow the blood to pass only toward the heart. In other words the vessels are divided into a series of chambers which can deliver their contents upward only. Every movement of the legs tends to compress the veins in one place or another and so forces the blood from one segment into the next above. One has only to stand still for a few hours to appreciate the discomfort of stasis brought about by the failure of muscular movement. The venous circulation will continue, however, though at a disadvantage, without such assistance. The vein walls are, normally, resilient, and, supported by the muscles and skin, will not stretch sufficiently to allow any important back flow past the valves. Under these conditions the gradual emptying of the vena cava brought about by variations of pressure in the thorax and the genle push of the capillary circulation, combine to keep the venous blood moving slowly on.

Unfortunately the great abdominal veins to which the blood is delivered from below have no valves. There is, then, a column of blood in these vessels unsupported save by the valves of the veins in the legs, a column drawn upward feebly by rhythmic alterations in intrathoracic pressure, but offering a considerable weight against which the blood from the extremities must rise; a column, in fact, subject to the changes of abdominal tension, and often, therefore, a menace to the integrity of the valves below it. To meet this strain, the veins of the legs are divided into two systems; the deep, among the muscles and well supported by them, and the superficial, lying in the subcutaneous tissues, and supported only by skin, superficial fascia, and fat. Of these two systems the former is considerably the more capacious and obviously the less liable to disability, while the latter, though it probably carries much less blood, is more exposed to trauma and derives far less support from the tissues outside its own vein walls. The two communicate by what are called perforating or communicating vessels, in which the valves are so set that blood can normally flow only from the surface veins to the deep. These perforating vessels, which vary considerably in number and distribution, offer, therefore, a safety valve for the superficial system (Figs. 1 and 2).

The surface veins may again be divided into two subsystems, the great or internal saphenous, and the lesser or external saphe-

nous. The great saphenous vein, after gathering radicals from the front and inner side of the foot and lower leg, passes upward, generally as a straight single trunk, inside the knee, along the inner anterior surface of the thigh, and into the femoral vein at the saphenous opening. The small or external saphenous vein drains the back and outside of the foot and leg, and empties in the popliteal space into the popliteal vein. It frequently communicates with its more important companion and, like it, is subject to considerable variation.

Distribution of valves. All the veins of the extremity are furnished with filmy, delicate, bicuspid valves. At infancy there are, between the foot and the groin, as many as fifteen to thirty sets in both great saphenous veins (Klotz, 6), but this number undoubtedly decreases even under normal conditions with advancing years. There is almost invariably a valve in the principal vessel just distal to each entering branch and one near the mouth of the entering vein as well. The valves of the deep and surface systems differ in no way from each other, and there is, more often than not, a valve in the femoral vein just above the point of entrance of the great saphenous. The arrangement of valves in the perforating veins, as has already been stated, allows of bloodflow toward the deep vessels only.

Summary of anatomic and physiologic considerations. The principal physiologic features, then, of the venous circulation in the legs are the following: The veins pass the blood upward through a series of chambers separated by bicuspid valves set to permit only an upward flow; this flow is favored by movements of the leg muscles assisted by the forces in the thorax which tend to empty the vena cava, and by the push of the capillary circulation; the walls of the veins must support a column of blood whose height is measured by the distance to the heart above, and inasmuch as the abdominal veins are valveless, the pressure upon the upper valve, or upon the vessel walls below it if this valve becomes incompetent, may be enormously heightened by increase in intra-abdominal tension; the deep veins of the legs have a strong muscular support outside their own walls, while the surface veins derive an adventitious support only from the superficial fat and skin; a system of vessels perforating the deep fascia communicates between the two, and owing to the arrangement of its valves, lightens to some extent the work of the latter.

ETIOLOGY AND PATHOLOGY

Etiology. For all practical purposes a varicose vein in the lower extremities may be described as merely a valveless vein or more properly a vein whose valves are incompetent. Having in mind this fact, one may obtain from a study of the circumstances under which varicosity becomes established and a knowledge of the pathologic changes which necessarily ensue, an explanation of the various forms which varix assumes and a rational basis for treatment.

The most obvious cause of the breaking down of the valves is hard work, by which I mean carrying or lifting heavy loads for long periods, as in the case of longshoremen, freight handlers, and laborers. The tension upon the abdominal muscles, the downward push of the diaphragm in violent breathing, in fact, the same strain which produces hernia, lays a heavy load upon the veins of the legs. Whether the valves become useless through stretching of the vein walls or are directly broken is immaterial. The occupations which involve standing for long periods without moving the legs are, in a lesser degree, a source of valvular incompetence, and this not from excessive back pressure but from stasis due to lack of muscular movement. Among women, the venous engorgement of the legs so often seen even early in pregnancy may, finally after the birth of several children, result in varicosity. I have also seen, in young men, and in young women who have never borne children, instances of varix which date from childhood, apparently due to congenital abnormalities. All these etiologic factors tend to produce the well known, large, surface varicosities.

A second and smaller group of cases arises from phlebitis. The "milk leg" after labor, the phlebitis of typhoid and of post-operative

convalescence all give rise to varix which can generally be distinguished from that due primarily to engorgement. The reason for this distinction becomes more clear when one considers the series of pathologic changes characteristic of the onset and establishment of varicose veins.

Pathology. It seems to be true, without going into the more minute pathologic anatomy, that varix may assume one of two principal forms, depending in a general way upon whether it results from overstrain and stretching of the vein walls, or from phlebitis. In the first case, the valves gradually become functionless, the vessel walls stretch until their nutrition is impaired, muscle-cells become replaced by inelastic scar-tissue, the vein becomes tortuous, local areas distend into pockets, calcification sets in, and indeed, all the variations commonly observed in scar-tissue, ill-nourished and under tension, are likely to occur. As the onset of these changes is naturally gradual, effective collateral circulation corresponding to the degree of stasis in the main channels is frequently established, and true varicosity is often confined to the trunk and principal branches of the great saphenous vein.

The ulcers which occur under these circumstances are almost without exception in direct relation to the varicose vessel or vessels. They are said to "ride" upon veins, occurring almost exclusively in the lower and middle thirds of the lower leg. Fundamentally their occurrence seems to be due to a chronic irritation of the skin associated with stasis of impure blood in the vein beneath, as attested by the pigmentation which so commonly precedes them, but a frequent contributory cause is undoubtedly trauma, and the form which they ultimately assume must depend greatly upon the degree of infection which follows their establishment.

The perforating vessels do not usually share in the varicosity of the large tortuous veins. In many instances they continue for years to fill their rôle of safety valves, carrying the stagnant blood from the surface veins into the deep system which is well able to care for it. When, however, they in turn become dilated the surface circulation becomes the more embarrassed in that blood may now pour out from the deep veins to the superficial. Under the circumstances ulcers are particularly prone to occur and that over areas independent of the veins themselves.

The first and more common variety of varicose vein is, then, dilated, sclerotic, tortuous; often sacculated and calcified. It is not necessarily associated with very noticeable changes in the nutrition of the leg, owing to the effectiveness of collateral circulation and the preservation of the useful perforating veins. Ulcers when present usually "ride" upon the principal varicose trunk. In the more advanced cases, particularly when the perforating veins have become incompetent, the general nutrition of the leg may be poor, and ulcers may develop over wide areas.

The second and less common variety of varicose vein arises from phlebitis. In this case the valves are suddenly and universally crippled, possibly by the organization of the thrombus, the vein walls are thickened and the lumen narrowed. The circulation through such a vessel is just as ineffective as through a large dilated channel. Ulcers often appear within a few weeks or months of the phlebitis. The great saphenous vein is almost invariably small, hard, straight, and thick-walled, but there are occasionally seen groups of very thin-walled surface branches as if a collateral circulation had been rapidly established and distended. The perforating veins are nearly always incompetent. The disturbance of the surface circulation is so profound that ulcers are often multiple and widely scattered over the lower leg. The skin and subcutaneous tissues over the whole calf and shin may become a mass of œdematous scar-tissue. The foot, however, rarely shares this appearance. Apparently it is well cared for by the deep vessels, perhaps aided by the support of the shoe.

CLASSIFICATION OF VARICOSE VEINS

From an etiological standpoint varicose veins should be divided into two groups; the first comprising those arising by gradual dilatation, and the second, those which take origin

in phlebitis. For purposes of treatment, however, this classification is unsatisfactory and it is better to divide them into: (1) surface varix, and (2) surface varix complicated by varicosity of the perforating veins. In the first category belong the large majority of instances of gradual dilatation and incompetence, and in the second, not only some of the more advanced cases of similar etiology, but almost without exception the cases of varicosity arising suddenly from phlebitis. Certain simple diagnostic measures distinguish these groups, which may, and usually do, demand characteristically different treatment.

Clinical tests. The methods by which the true nature of varicose veins was first effectively demonstrated were devised by Trendelenburg (1), who showed that in varix there is nothing to prevent a back flow of blood in the veins, and actually measured the pressure which the long column of blood exerted against the vessel walls in the leg. The tests devised by Trendelenburg are easily performed. The leg is raised and held above the level of the heart until the veins are empty. It is then rapidly lowered when the blood can be seen to flow back into the leg and suddenly distend the surface vessels. This test for varicosity may be positive even when the reflux cannot be seen to distend the vein walls, for if the veins are so sclerosed that no change in the tension of their walls can be noted by the eye, it can quite readily be felt by the fingers.

By such means, valvular incompetence of the surface veins as opposed to hypertrophy or distention of normal vessels can be diagnosed, but still more information may be derived from a variation of the same simple procedure. Suppose it has already been determined that the surface veins allow a free back flow. The leg is now raised and the veins emptied of blood. If, before it is lowered, a constriction only firm enough to compress the surface vessels, as by a piece of bandage, is made about the upper thigh, blood cannot flow from above into the varicose superficial veins, and until they are filled by the natural circulation they remain empty.

This, French writers have called the *contre-épreuve* of the Trendelenburg test, and it confirms the diagnosis, for on releasing the constriction, the empty or partially filled veins become distended with a palpable shock. But this procedure tells even more. Suppose the perforating veins share the varicosity of the surface vessels. The blood in the deep veins will then be able, as normally it cannot do, to leak into the surface vessels, and in applying the constriction test it will be found that in spite of the prevention of back flow down the superficial veins, these fill rapidly below the constriction. That is to say, blood is finding its way out from the unobstructed deep veins through incompetent perforating vessels to the surface. In varicosity of the surface veins alone, filling below the constriction takes place in three-quarters of a minute or more and even then these vessels may not be very tense, for the perforating veins are continually carrying off the excess of blood. If, on the other hand, the perforating veins are incompetent, the surface vessels will fill below the constriction, possibly in ten, twenty, or thirty seconds, according to the importance of the leak.

These two tests, which I shall hereafter call respectively the Trendelenburg test and the constriction test for perforating veins, serve to separate the cases of pure surface varicosity from surface varicosity complicated by varicosity of the perforating veins. The tests ignore the possibility of varix of the deep venous system, a very rare condition if indeed it is every fully developed.

SURFACE VARIX

Distinguishing features (Fig. 3). This condition is distinguished by the demonstration of a free back flow down the surface veins (a positive Trendelenburg test) and by the failure of the lower surface veins to fill in the application of the constriction test for incompetent perforating vessels (a negative constriction test). In the performance of the second test, three-quarters of a minute to a minute is taken as the normal filling time for the varicose surface veins below the constriction. A more rapid filling indicates some incompetence of the perforating chan-

nels. In some cases of pure surface varicosity, however, the superficial veins never fill completely below the constriction apparently because they are effectively drained by the communicating veins. Such cases are often distinguished by a single enormous, tortuous, great saphenous trunk passing from groin to ankle, but even in instances of very general surface varix the effectiveness of the collateral circulation and perforating channels in caring for the stagnant surface blood is often surprising.

The diagnosis of varicosity restricted to the surface veins is not difficult except, first, in the borderline cases in which the superficial veins fill slightly more rapidly than normally in the constriction test, and second, when there is a dense area of scar-tissue as a result of a long-standing ulcer in the lower leg. In the first instance it is better to consider that the perforating veins are, in fact, incompetent. In the second, a negative test for varicose perforating vessels means nothing, for the dense scar-tissue may effectively conceal the local reflux of blood from the deep channels. Under these circumstances the diagnosis can be established only at operation.

Operative procedure in surface varix. Relatively simple surgical measures may be employed to cure pure surface varices, and the least radical of these is the so-called Trendelenburg operation. The original operation was a simple ligation of the great saphenous vein in the thigh and was intended to relieve the veins below the ligature of back pressure due to the long column of stagnant blood. It has been modified into the excision of a short piece of vein between ligatures in order to prevent the reëstablishment of a channel, and this excision is performed as close as possible to the saphenous opening. The main trunk of the great saphenous may even be divided in several places (Schwartz, 7), cutting it up into a number of isolated segments in which the blood soon organizes and obliterates the lumen.[1]

The Trendelenburg type of operation is to be advised as a palliative measure in instances of varicosity of the great or lesser saphenous veins only when the perforating veins are proved to be competent. Inasmuch, however, as the great vein is not actually removed and not necessarily obliterated, there is always a fair chance of recurrence through the reëstablishment of its channel by the aid of collateral circulation or by the formation of new veins in the scar-tissue separating the ends of the divided segments. Therefore the operation should only be performed upon the aged or infirm, or perhaps to tide a young person over a difficult period, or indeed, merely to heal an ulcer temporarily. An analysis of the results of this operation in the hands of various surgeons shows an anatomical recurrence after five years in 60 to 70 per cent of the cases, but with symptomatic recurrence in only 20 to 30 per cent (Miller, 8).

The radical operation, and one to be advised for the cure of the common surface varix without the involvement of the perforating vessels, is Madelung's full excision of the great saphenous vein. The exact method of performing this operation is less to be considered than a general scheme which will satisfy the following requisites: first, that the great saphenous vein (and the lesser if involved) should be eradicated in such a way that there is no possibility of the reformation of its channel or the formation of a similar channel; second, that the ulcer or ulcers if present be permanently healed; third, that the wound or wounds should heal soundly and not interfere with the nutrition of the skin.

The radical removal of the surface veins is perhaps most satisfactorily performed upon the following plan: A transverse incision several inches long is made in the groin about an inch below Poupart's ligament. Through this incision the great saphenous vein is divided at the saphenous opening. At the same time any other veins which parallel it or enter from above are found and divided in order to do away with any vessels capable of reëstablishing a large, single, collateral trunk. The internal saphenous is then dissected out with the Mayo stripper or other appropriate means down to the region just

[1] Recently Kuzmick (3) has made use of an operation originally devised by Schede (2) which consists in percutaneous ligation of the great saphenous vein at short intervals throughout its entire length. No incisions are made, convalescence is short, and the results are said to be good.

below the knee. At this point open dissection should begin, for here the larger branches of the great vein begin to enter it, and though breaking the long column of blood by removal of the internal saphenous from groin to knee is likely in many instances to cure, it is always advisable carefully to dissect out the varicose vessels of the calf down to the point where they appear small and harmless. This is most easily done by a long incision to the deep fascia, turning back thick flaps of skin and fat, and dissecting the veins from inside the flaps.

The fulfilling of the second requisite, the cure of the ulcer, depends for its success principally on the accomplishment of the first, that is, the complete removal of the veins. It is often advisable, however, in removing the largest veins to take with them what may be called their tributary ulcers. Moreover, as was first pointed out in this country by the Mayos (9), if in association with the ulcers there has been found a very thick impenetrable base of scar-tissue, it is almost always necessary, in order to secure healing of the ulcers, to remove with them down to, or better, through the deep fascia the mass of scar-tissue beneath and about them; otherwise the poorly nourished tissue may harbor a leaking perforating vessel not disclosed by the tests and may never permanently heal. In consequence of laying bare this oftentimes enormous area, an immediate skin graft (Thiersch preferably) completely covering the denuded surface should be performed, and it is notable that such grafts "take" well upon fat, fascia, or even periosteum.

Finally, in securing the third requisite, the adequate nourishment of the skin and the proper healing of the wound after the dissection required by these procedures, perfect asepsis, perfect hæmostasis, and delicate handling of tissues are of the first importance. In this respect the method of making thick flaps of skin and fat is particularly useful, and rather than exert much traction on the flaps it is always better to make a transverse incision at the lower end of the long wound, half way round the leg if necessary, in order to secure greater ease of dissection. It is also a good rule to use one set of dissecting instruments for the early part of the operation upon the thigh, a second set for the dissection of the calf, and a third set for closure of the wounds in the thigh, if closure has not been effected before the dissection of the lower leg. The selection of fresh instruments is highly desirable inasmuch as forceps must almost of necessity become contaminated by handling the borders of incisions, particularly in scarred and often-ulcerated tissues of low bacterial resistance. Finally, it is generally advisable to close all wounds subcutaneously with interrupted catgut stitches and in the lower leg to close incisions very loosely, making use of no superficial skin sutures whatsoever.

SURFACE VARIX COMPLICATED BY VARICOSITY OF THE PERFORATING VEINS

Distinguishing features (Fig. 4). The cases falling under this head differ very considerably from each other in appearance. Varicose vessels may be numerous and prominent, or few and almost invisible. In the second instance, the patient's discomforts are strikingly greater than the apparent degree of varicosity warrants. Ulcers, particularly in those whose circumstances prevent them from nursing their ailments, are common. The constriction test shows that the surface vessels fill rapidly below the constriction by way of the varicose perforating channels. Nevertheless the findings may be difficult to interpret.

The simplest and perhaps least common cases are those having the appearance of advanced surface varix, perhaps without any marked formation of scar-tissue about the veins and in the subcutaneous tissues in general. More difficult to classify are those patients whose surface vessels are equally varicose but whose perforating veins are only incompetent after long standing, recovering their function after some days rest in bed. Most difficult of exact diagnosis are the instances of great obesity when the veins can barely be distinguished by palpation, and those cases of varicosity, almost invariably the result of phlebitis, in which the great saphenous vein is small, thick walled, and

palpated with difficulty amid the indurated and œdematous tissues of the lower leg. Even an expert sense of touch may then fail to note the emptying and filling of the veins unless some good sized surface branch happens to be at hand. The Trendelenburg test is oftentimes not immediately positive—that is to say, the blood does not pour down the veins with a shock, but fills them in a few seconds—and the constriction test is positive after a somewhat longer interval. Occasionally the veins are so small, hard, and obscured by scar-tissue that the exact character of the venous reflux can be observed in them neither by sight nor by palpation, and one must infer the diagnosis by observing the absence or presence of cyanosis in the lower leg during the performance of the tests.

Paradoxical law of varicose veins. Straight small, thick walled veins of the post-phlebitic type are almost unnoticeable, yet the lesions which habitually mark their presence—ulcers, œdema, atrophy of the skin — are obstinately resistant to treatment, and it may perhaps be stated as a law, that the less noticeable the veins, the more malignant and resistant the accompanying ulcers, and the more radical and thorough must be the curative operation. Large tortuous surface varicosities are gradually established, perforating vessels and collateral circulation are then usually competent, ulcers if present ride on veins, and cure is usually easy. On the other hand, the varicosity of the small sclerosed surface vessel is rapidly established by inflammatory processes, collateral circulation is ineffective, perforating veins are almost invariably crippled, disturbances in the skin are widespread and severe, and cure is correspondingly difficult.

Operative procedures. It is in the treatment of these complicated conditions that the adaptation of the surgical procedure to the individual case is so important and accordingly, after indicating in a general way what seem to me ideal principles, I shall cite a number of instances from the Peter Bent Brigham Hospital series in which operative variations have been adopted. In simple surface varix it is seldom necessary to do more than remove the great saphenous vein from groin to mid-calf. In surface varix complicated by varicosity of the perforating veins, not only must the great saphenous be eradicated but many of its branches in the calf must be followed and excised in the search for incompetent perforating channels. If these channels are not ligated they will continue to remain a source of venous stasis, and inasmuch as they are frequently found beneath ulcers in the center of great masses of scar-tissue, their removal is generally as difficult as it is imperative.

All such operations require the usual transverse incision below Poupart's ligament and resection of the great saphenous vein in the thigh. When the lower leg is not so densely indurated as to forbid free dissection of the calf, large, thick flaps should be turned back after the method of Madelung to expose the deep fascia of the front and inner side of the leg. The surface veins are dissected from the internal surface of the flaps and in this dissection the varicose perforating vessels are likely to be found (I have never recognized in the calf more than three, seldom more than two). They are tied beneath the deep fascia. When an area of scar-tissue is encountered, whether or not it is the seat of ulcer, the judgment of the operator must determine the thoroughness with which this tissue shall be dissected. If an ulcer is present, the whole mass of scar-tissue is best excised and its base skin grafted. If ulcers have formerly existed and healed, a linear cut may be made through the indurated region and flaps turned back as usual. In this case the wound should be very loosely approximated.

In some instances, however, the whole leg below the knee is so œdematous, indurated, and covered with ulcers that not only is the resection of the principal surface vessels a difficult matter, but the turning back of skin flaps for thorough dissection is impossible. It is under these conditions that the spiral cut of Rindfleisch is perhaps indicated, though I prefer to make multiple incisions, either transverse as a modification of the "garter" operation of Schede, or perhaps more safely in a perpendicular direction. Indeed, it is

wisest if the operator has the confidence of his patient, after doing away with the great saphenous vein above the knee, to work up the leg making multiple incisions at several sittings, picking up and tieing one by one the varicose perforating channels as one passes up the leg after the method of Novaro (10). In any case the object of the operator should be, I believe, to abolish the continuity of all surface veins of any considerable size, and to find and divide, or at least cut off from the surface circulation, the varicose perforating veins. If this is accomplished, the superficial circulation is carried on by small vessels emptying probably by way of devious connections in the thigh. The skin of the lower leg may perhaps remain œdematous but ulcers will not tend to recur. The operator must keep in mind that tissues served by almost invisible channels are better off than those drained by a varicose vessel.

CIRCULATORY ABNORMALITIES OF THE GREAT SAPHENOUS VEIN

The great saphenous vein is limited to the thigh. The lower leg is then drained by one or more trunks similar in distribution to the lesser saphenous, perforating the deep fascia above the knee and joining the deep veins in the thigh. This abnormality has been twice noted at operation in the Peter Bent Brigham Hospital series of about seventy cases. It is difficult to diagnose, however, as the great saphenous in the thigh lies so deeply embedded in fat and is often so difficult to trace that its failure to connect with the varicose vessels of the calf is overlooked. The signs due to this abnormality are similar to those of varix of the lesser saphenous, that is, the veins in the lower leg fill with the same rapidity whether or not a constriction is applied to the mid-thigh, but may fail to fill upon the application of the constriction test at the level of the knee. At operation the great saphenous is found to end above the knee and a large varicose trunk, passing upward to perforate the deep fascia in the thigh, is encountered in the dissection of the inner side of the lower leg.

The great saphenous vein is double. This abnormality should be kept in mind and may account for some operative failures especially after insufficient dissections. It has not been noted in the Brigham Hospital series, though recorded by others.

VARIX OF THE LESSER SAPHENOUS VEIN

Varix of the lesser saphenous vein unaccompanied by varix of the great saphenous. This is an unusual condition and has occurred four times in this series. The diagnosis is fairly obvious as the varicose veins are confined to the back and outside of the lower leg, and do not extend above the popliteal space. The Trendelenburg test is positive. The constriction test if applied in the mid-thigh is equally positive, but if the constriction is applied below the point where the lesser saphenous enters the deep fascia it is positive or negative according as the vein has or has not varicose perforating connections below. The treatment is radical excision. Ulcer, if present, is close above the heel and is best excised with the vein.

Varix of the lesser saphenous vein accompanying varix of the great saphenous. This condition is not at all uncommon. The varicosity of the lesser saphenous may perhaps arise independently, but seems more often to be due to communication with the larger vessel. The diagnosis between these two conditions can usually be made by finding whether or not the branches of the two systems show similar or independent reactions to the usual tests. In either case the treatment includes excision of the lesser saphenous trunk for several inches at least below and above its varicose connection with the great saphenous.

GENERAL CONSIDERATIONS IN REGARD TO CLASSIFICATION AND TREATMENT

Not all instances of varix appear to fall under the classification here referred to. A not uncommon condition is that of moderately developed superficial varicosity in which the veins are shown by the Trendelenburg test to be only partially incompetent and there is no tendency to ulcer formation. The patient's discomfort is, however, great, particularly upon standing for long hours, and I have the impression that under these cir-

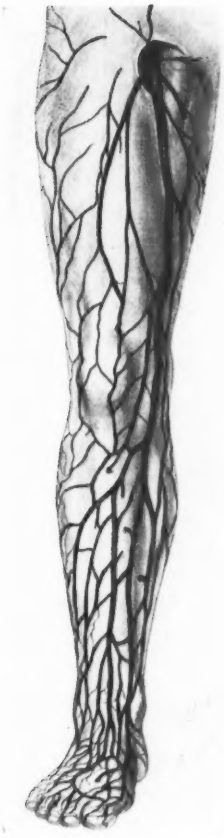

Fig. 1.

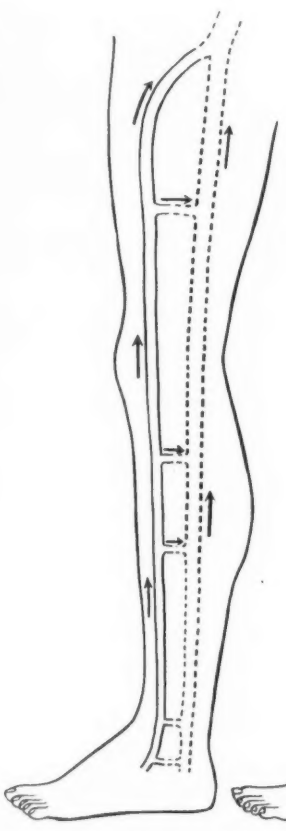

Fig. 2.

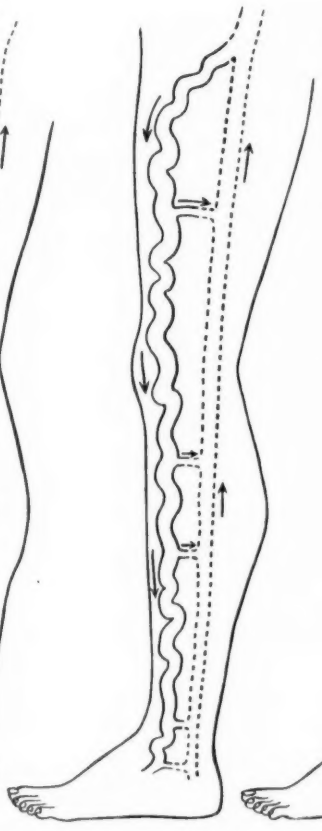

Fig. 3.

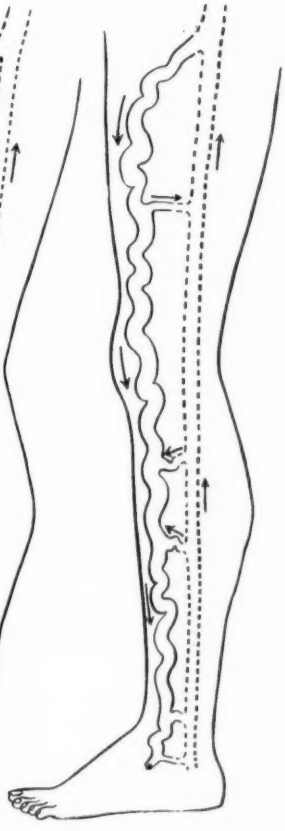

Fig. 4.

Fig. 1. The superficial veins. The great saphenous and its branches. Notice the region of the perforating vessels.

Fig. 2. Diagram showing normal direction of blood current in the superficial and deep systems. Notice directions of current in the perforating vessels.

Fig. 3. Diagram showing direction of blood current in superficial varix with normal perforating vessels. The perforating veins drain the surface vessels.

Fig. 4. Diagram showing direction of blood current in superficial varix with incompetent perforating vessels. The perforating veins add to the disability of the surface vessels.

cumstances varicosity in the great saphenous is in the process of development and that collateral circulation is as yet unestablished. Such cases are probably ill-adapted to radical operation inasmuch as removal of the only partially incompetent great saphenous vein is likely to throw a sudden strain upon the smaller surface vessels with resulting dilatation, general œdema and possibly ulceration of the skin. One case of this kind in the Brigham series was subjected to operation, and though the result at the end of a year appeared excellent, there was at first considerable swelling, œdema, and added discomfort.

Another and more uncommon deviation from the usual types is seen in local dilatation and advanced sclerosis in certain groups of vessels, unaccompanied by any noticeable change in the great saphenous in the thigh. Here the Trendelenburg test will show that the main channel is indeed varicose though it can neither be seen nor felt. In one such

Fig. 5. Case 1. N. A. McD. Surface varix. Note large size and tortuosity of single varicose vein. Ulcer rides on vein.

Fig. 6. Case 1. Surface varix. N. A. McD. After operation. The transverse incision in groin does not show. Two years after operation.

instance it was found that the great saphenous in the thigh, though valveless and irregular in caliber was small and thin walled. Its large branches above the knee were abnormally numerous and one of these could be followed down the leg to the foot as a typically varicose vessel. A group of markedly varicose veins in the lower leg communicated with it.

Such are some of the variations from classic types which have been noted in the Brigham series. It is safer to regard such unusual cases as subjects for the most careful study and exploration. Exploratory incision and examination of the great saphenous vein in the groin may be required to establish the diagnosis. How far syphilis may play a part in the unusual as well as in the more common varieties of varix is difficult to say. Wassermann reactions have been almost universally made in this series and have almost invariably been negative. The mere existence of syphilis neither proves that disease is etiologically important in varix nor is its cure, if present, likely to influence to any extent the mechanical deficiencies of fully established varicose veins.

Preparation of patients for operation and after-care. All patients with varicose veins are best kept in bed for several days before operation. No especial attempt need be made to render the skin sterile except the usual wash and shave the evening before operation. Moreover, it is quite unnecessary, except in unusually advanced cases, to wait for the healing of ulcers, for the ulcer area can be kept covered during the dissection of sound tissues, and when included in the operation it is either excised, or transected and loosely closed.

After operation the ankle and knee should be immobilized by a crinoline bandage with or without a ham splint. Immobilization need not be maintained longer than a week, but a firm bandage should be applied to the calf, especially when the patient is very obese, for two weeks in all. At the end of this time, if the incisions are well healed the leg should be exercised in bed and the patient may begin

Fig. 7. Case 2. Surface varix. T. J. C. Note huge surface vein in right thigh and general enlargement of veins of calves. The great saphenous vein in the left thigh has been removed at a previous operation. The small saphenous vein is keeping up the stasis in the surface veins of the left calf.

Fig. 8. Case 2. Surface varix. T. J. C. After operation. Right leg, usual incisions for excision of great saphenous vein. Left leg, note long postero-external incision for excision of lesser saphenous vein.

to get up. Upon beginning to walk a supporting bandage from toes to knee should be worn for several weeks. After this time all bandages should be discarded for they may, if tightly applied, be actually harmful.

PROTOCOLS OF ILLUSTRATIVE CASES[1]

CASE 1. *Surface varix.* Surgical 280, N. A. McD., female, age 30 (Figs. 5 and 6). Duration of disease: five years, in right leg only. Etiology: gradual onset with childbearing. Ulcer, present, of four months duration—rides on vein, little induration. Trendelenburg test: positive, filling immediate. Constriction test for perforating veins, negative, filling below constriction incomplete in 35 seconds.

[1] These cases are not selected as typical end-results. In some of them, the ideal operation is indicated in comment upon the procedure employed. In others the procedure is described and illustrated which experience has shown to be ideal though the operation is of recent date. In a critical study of this kind, improvements in technique have necessarily waited upon the observation of early successes and failures. At a later date an analysis of the entire series with end-results will be published.

Operation. July 31, 1913. Transverse incision in groin. Stripping of vein in thigh. Stripping of two principal branches in calf just above ulcer which was not excised. Result, June 28, 1915: No return of symptoms. Perfect result (See Fig. 6).

NOTE.— In view of the nature of the ulcer in this case the failure to excise it is perhaps justifiable, though it might have been excised with the principal vein.

CASE 2. *Surface varix.* Surgical 3131, T. J. C., male, age 50 (Figs. 7 and 8). Duration of disease: nine years, in both legs. Etiology: heavy lifting (freight handler). Ulcer, present off and on for 7 years. Second ulcer recently, following a palliative operation. Trendelenburg test: right, positive, filling immediate; left, positive, filling in 6 seconds. Constriction test for perforating veins: right, negative, filling below constriction in 45 seconds; left (constriction in mid-thigh), positive, filling below constriction in 20 seconds; left (constriction over popliteal space), negative, filling below constriction in 45 seconds.

NOTE.— These tests upon the left leg place the incompetent perforating vein in the upper part of the popliteal space and suggest the small saphenous

Fig. 9. Case 4. Surface varix with varicosity of perforating veins. Large vessel type. E. M. D. Lateral view of right leg.

Fig. 10. Case. 4. Surface varix with varicosity of perforating veins. Large vessel type. E. M. D. Posterior view.

vein as the offender. This was proved at operation to be the case, and explains the failure of the previous operation.

Operation, June 28, 1915. (A previous local operation at another institution had been performed upon the left leg a year or two before with multiple divisions of the great saphenous vein. The clots in the isolated segments became infected so that the great saphenous trunk in the thigh was for the most part removed, yet a new ulcer occurred, and the veins of the calf never diminished in size as shown in the accompanying photograph. They undoubtedly were filled from the varicose small saphenous vein. The patient had fully realized the probability of failure from this palliative operation which the surgeon had performed under protest to relieve immediate distress.)

Right leg: transverse incision in groin; stripping and free dissection of vein in thigh; dissection of calf (narrow flaps) and excision of strip of skin adherent to veins. Left leg: transverse incision in groin; removal of a short segment of vein above the upper incision of the former operation. Long incision inside calf (narrow flaps), excision of many varicose vessels some passing backward toward small saphenous vein. Second long incision in midline posteriorly (narrow flaps). Excision of varicose small saphenous vein, nearly to ankle, and of several varicose branches which had evidently communicated with the great saphenous in the calf. Immediate result. Healing (Fig. 8).

CASE 4. *Surface varix with varicosity of perforating veins. Large surface vein type.* Surgical 2973, E. M. D., female, age 50 (Figs. 9, 10, 11, 12). Duration of disease: 8 years. Etiology: childbearing, gradual onset in both legs. Ulcer, recently in right leg over an area of thrombosis in calf. Trendelenburg test: right, positive, filling in 5 seconds; left, positive, filling in 15 seconds. Constriction test for perforating veins: right, positive, filling below constriction in 20 seconds; left, doubtful, filling below constriction in 30 seconds.

Operation, May 28, 1915. Right: transverse incision in groin; stripping vein in thigh to knee; full dissection of calf with wide flaps, excising thrombosed vessels and area of poorly nourished skin; two incompetent perforating veins found and ligated. Left: transverse incision in groin; stripping vein in thigh; dissection of calf (narrow flaps); removal of many large branches including upper portion of small saphenous vein which was particularly varicose.

Result (Figs. 11 and 12): immediate healing.

CASE 5. *Surface varix with varicosity of perforating veins. Post-phlebitic—small vessel type.* Sur-

Fig. 11. Case 4. E. M. D. After operation. Compare with Fig. 9.

Fig. 12. Case 4. E. M. D. After operation. Note incision in each popliteal space for resection of each small saphenous vein, and large flap on back of left calf. Compare with Fig. 10.

gical 416, M. N., female, age 29, single (Fig. 13). Duration of disease: discomfort for 14 years. Has never noticed enlarged veins. Etiology: severe burn of body in childhood, both legs swollen and painful at this time; probably phlebitis. Ulcer, for 2 years in both legs. Trendelenburg test: positive, filling in 10 to 12 seconds. Constriction test for perforating vessels: positive, filling below constriction in 22 seconds.

Operation, October 1, 1913. Transverse incisions in groins; stripping in thighs; broad flap dissection of both calves with transverse incisions above ulcer areas; ulcers not excised. (No note of condition of perforating vessels.) Immediate healing; later, reported recurrence of ulcers.

Result, June 29, 1915. Patient reports herself well. Not seen, as she had left the city.

NOTE.— Possibly incomplete operation. Incompetent perforating vessels may exist beneath ulcers. Ulcer areas should have been excised down to sound tissue. Elapsed time after operation (2 years) too short to be certain of cure under the circumstances.

CASE 6. *Surface varix with varicosity of perforating veins. Post-phlebitic—small vessel type.* Surgical 2007, P. T., male, age 58 (Figs. 14 and 15).

Fig. 13. Case 5. M. N. Note large discolored areas and ulcers, and absence of visible varicose veins.

Fig. 14. Case 6. P. T. Surface varix with varicosity of perforating veins. Small vessel type, post-phlebitic. Note large ulcer area upon right leg and absence of visible varicose veins.

Fig. 15. Case 6. P. T. Nine months after operation. Note grafted area and character of incision in calf. The incision in the groin is partly in shadow and does not show. Compare with Fig. 14.

Duration of disease: 4 years, in right leg. Etiology: injured leg 4 years ago. Phlebitis at this time (?).

Patient is a stationary fireman. Heavy lifting; long hours on feet. Ulcer, for 4 years. Irregular, unhealthy granulations. Trendelenburg test: positive, filling time 2 to 4 seconds. Constriction test for perforating vessels: negative, filling below constriction in 45 seconds. An extensive scar prevents accurate test.

Operation, November 5, 1914. Transverse incision in groin; stripping vein in thigh, broad flap dissection of calf; excision of ulcer. Large perforating varicose vein found beneath ulcer. Secondary skin graft (Reverdin), (Fig. 15). Immediate result good; slow convalescence.

Result, July 29, 1915. Perfect; patient at work; skin of calf including grafted area looks healthy.

NOTE.— Larger area should have been excised and grafted at once, but ligation of the perforating vein beneath the ulcer made the cure almost certain.

CASE 7. *Surface varix with varicosity of perforating veins. Post-phlebitic—small vessel type.* Surgical 419, J. M., male, age 52. Duration of disease: 2 years. Has never noticed enlarged veins. Etiology: phlebitis accompanying typhoid fever. Ulcer, multiple, scattered over a reddened œdematous lower leg. Appeared immediately after recovery from typhoid and never healed even after three weeks rest in bed. Trendelenburg test: Positive, filling time, 1 to 2 seconds. Constriction test for perforating veins: positive, filling below constriction in 1 to 2 seconds.

Operations, September 26, 1913. Transverse incision in groin. Stripping in thigh (small thick-walled straight vessel). Flap dissection of upper calf. Two transverse incisions, half encircling leg. Several incompetent perforating veins found. October 2, 1913. Several more transverse incisions interdigitating with first set. Healing. April 9, 1914. Return of 2 ulcers. Further transverse incisions. Immediate healing.

Result, November 9, 1914. No ulcers; no pain; steadily at work; wears a light bandage.

NOTE.— This case would perhaps have been suitable also for a spiral incision. In my opinion short incisions at several sittings are more satisfactory.

CASE 8. *Surface varix with varicosity of perforating veins. Post-phlebitic, small vessel type.* Surgical 1950, T. C., male, age 38 (Figs. 16 and 17). Duration of disease: 7 months. Has never noticed enlarged veins. Etiology: phlebitis following pneumonia, 3 years ago. Ulcer present, for 7 months, multiple (4) in large œdematous scar-like area. Trendelenburg test: positive, filling in 1 to 2 seconds.

Fig. 16. Case 8. T. C. Surface varix with varicosity of perforating veins. Small vessel type, post-phlebitic. Note multiple ulcerations and absence of visible varicose veins.

Fig. 17. Case 8. T. C. At close of operation. The great saphenous vein has been excised in the thigh. Note distribution of incisions and loose closure of wounds.

Constriction test for perforating veins: positive, filling below constriction in 20 seconds.

Operation, October 25, 1914. Transverse incision in groin; stripping thigh; full dissection of calf with flaps. Straight thick-walled small saphenous vein. Several incompetent perforating veins found. Multiple incisions (longitudinal through ulcers); partial resection of small saphenous vein (slough occurred on back of calf near this incision).

Immediate result, good. Ulcers healed. Late result, July 26, 1915. This case, like the previous one, required multiple incisions at several sittings. This was explained to the patient but he has not returned to the hospital. He is known, however, to have two ulcers instead of four. The result is a failure in that ulcers are still present, and illustrates the difficulty of treating such a condition without the coöperation of the patient.

CONCLUSIONS

1. Varicosity of the veins of the legs is confined for anatomic and physiologic reasons to the superficial and perforating vessels.

2. Trendelenburg's tests distinguish between pure surface varix and surface varix complicated by varicosity of the perforating veins, a distinction important for purposes of treatment.

3. Surface varix is curable by relatively simple surgical procedures, preferably excision of the great saphenous vein from groin to mid-calf.

4. Surface varix complicated by varicosity of the perforating veins requires for its cure not only eradication of the great saphenous vein but a thorough exploration of the lower leg in order to ligate varicose perforating veins.

5. Varix following phlebitis is not uncommon, presents a characteristic appearance, is prone to be complicated by varicosity of the perforating veins, and is usually accompanied by obstinate ulceration soon after its establishment.

6. It is a very general rule if not a law, that the more prominent and tortuous the surface veins the simpler the cure; the less

noticeable the surface veins the more malignant and resistant their attendant ulcers and the more radical the operative procedure required for cure.

7. Varicose ulcers, if of long standing and especially if they are surrounded by an area of thick scar-tissue, are best treated by free excision and immediate skin graft in connection with the radical removal of the veins to which they are tributary.

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QUIET HIP DISEASE

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FIVE years ago, it was noticed by one of the writers that certain hip cases in children ran a very mild course without the usual complications and terminal disabilities of tuberculous hip disease. The trouble usually began from the fifth to the tenth year with a moderate limp, often with little or no pain, and was associated with characteristic symptoms. A study of 22 such cases shows a definite group in which the cases resemble each other clinically and differ from cases of tuberculosis, coxa vara, and other hip affections.

The onset is usually very insidious, an inconspicuous limp coming on gradually without any known cause. Three of the cases, however, had an acute onset with fever and in two of these there was polyarthritis. In only four of the cases was there a history of trauma, the limp appearing one, three, nine, and twelve months after the injury. Mobility at the hip is often only slightly restricted at first and spasm is absent, but later, lateral motion and rotation in flexion, especially abduction and internal rotation, may be much limited and there may be some spasm on attempting to force the motion. The plane of flexion is usually deviated outward, but flexion to nearly 90°, and often beyond, is preserved. The mobility resembles that of an early period of osteo-arthritis in the adult.

Pain may be present at some stage of the affection, usually after overactivity, and may be in the hip, knee, thigh, or groin, and night cries sometimes occur; but pain is rarely an important or conspicuous symptom; some patients run their course with scarcely any at all.

Fig. 1. Case 1, right quiet hip, one and a half years' duration.

Fig. 2. Terminal condition, Case 1, six and a half years after onset.

Fig. 3. Case 2, left quiet hip, one and a half year's duration.

In some of the cases there is no shortening of the affected limb; but in the majority there is a shortening of one-quarter to one-half inch; in two cases, there was a lengthening of one-quarter inch. In most of the cases there is moderate atrophy of the limb. In the cases with shortening, the trochanter is elevated; in some it is effaced; in others, prominent. Trendelenburg's symptom is present.

These children are, as a rule, in excellent health and are fairly active; they never have toxæmia, abscess, enlarged glands, fixed deformity, ankylosis, serious suffering, or disability. The symptoms have some resemblance to those of coxa vara and to some cases of slipped epiphysis and hæmorrhagic osteomyelitis, or cysts of the neck of the femur; but they are easily distinguished by the röntgenogram, which shows a thin, flattened epiphysis, which may appear to be divided into separate pieces, and which, as the affection progresses, spreads or creeps over the top of the neck toward the trochanter. The epiphyseal line is irregular and broader than normal, especially at its upper part and the acetabulum often appears irregular. When the case is moderately advanced the neck is short and thick, but there is no notable amount of coxa vara. In some cases there are clear spots near the epiphyseal line. There is no hyperostosis, nor apparently any real erosion, though there may be extensive flattening or crushing and possibly inhibition of bone formation. These appearances are quite different from those of any other hip affection. The cloudy or foggy appearance and marked local bone atrophy, an early symptom in tuberculosis, are absent, though there may be some bone atrophy of the limb from disuse.

The affection lasts from one to three years and terminates in recovery with a remodeled joint, but with excellent use. The articular surface of the femoral head is extended toward the trochanter and is somewhat flat, but becomes smooth, and there remains a considerable amount of free motion. The limping and pain, if present, disappear, and only the slight restriction of motion and the changes shown by the röntgenogram remain to identify the process. Ankylosis, fixed flexion, or adduction which are so common after hip tuberculosis, do not occur.

In our 22 cases, the age of onset varied from four to sixteen; six were girls and sixteen were boys; in fifteen cases the right, in six cases the left, and in one case both hips were affected. In two or three others, the röntgenogram showed some thickening of the neck on the well side, but there were no symptoms. None of the nine cases in which the Wassermann test was applied gave a positive reaction. Two cases were tested with tuberculin; both were negative. Many of the cases had been treated for longer or

Fig. 4. Case 3, right quiet hip; terminal stage five years after onset.

Fig. 5. Case 4, right quiet hip; two years' duration.

Fig. 6. Case 5, right quiet hip; one and a half years' duration.

shorter periods with the short plaster spica, which usually relieved pain; others had crutches, or traction in bed; several had been treated for rheumatism or had had no treatment. The tendency is to overtreatment on an erroneous diagnosis of tuberculosis of the hip. Most of the cases that received little or no mechanical treatment did well. It is well, however, to apply a short spica for short periods, if pain is troublesome or persistent, and to suspend the limb by the use of crutches if deformation of the head is progressing rapidly; activity should be moderately restricted. Traction, braces, operations, and long periods of recumbency are unnecessary, if not detrimental.

The writers believe that this affection is a definite clinical entity which it is important to separate from tuberculosis, syphilis, coxa vara, and some of the rarer hip affections. It is evidently not very rare and its inclusion with cases of hip tuberculosis must have seriously distorted the symptomatology and statistics of that disease, especially as to the results of treatment.

Quiet hip disease in childhood is unquestionably one source of the affection known as osteo-arthritis of the hip in adults. One such case (Case 6) is reported in our case histories.

Some of the mild and obscure hip cases in children, where the diagnosis has been uncertain, are cleared up and shown to be quiet hip disease after careful raying. In order to avoid error, it is necessary to ray all hip-joint and borderline cases.

When, after studying our cases, we came to look up the literature, we found it quite extensive. Legg, of Boston, read a paper on "An Obscure Affection of the Hip-Joint," before the American Orthopedic Association, in 1909, in which he reports six cases of quiet hip disease. About the same time, Waldenström published a series of cases which he called tuberculosis of the upper part of the neck of the femur; these correspond with the cases here described as quiet hip disease; he found positive tuberculin reactions in his cases, but these are so common in children at the ages tested as not to be by any means decisive as to the local process. An excellent paper by Delitala appeared in the *Journal of the American Orthopedic Association* for April, 1915, and Allison and Moody, as well as the writers of the present article, read papers at the meeting of the American Orthopedic Association in May, 1915. The German and Scandinavian literature is quite copious, the classic paper being that of Perthes on osteochondritis deformans juvenilis, published in 1913. The affection is generally known in Europe as osteochondritis of the hip, or Perthes' disease. Perthes removed a specimen by an operation and was surprised to find that the head of the femur, though somewhat irregular, was covered with smooth

Fig. 7. Case 7, right and left quiet hips; duration of right a year and a half, of left three months.

and normal cartilage; he also found detached and semi-detached islands of cartilage near the epiphyseal line, which explained the clear spots often seen in the röntgenogram. He found no indications of an infectious process. It is thought by some that the affection is due to disturbed osteogenesis from the blocking of nutrient vessels by trauma or other causes. Delitala believes the underlying cause to be a congenital defect. After all is said, the cause of the affection remains obscure and for this reason the simple name of "quiet hip disease" based on the general clinical picture is proposed as a provisional title until the pathology is worked out.

Abstracts of the histories of twenty-two cases which have been under our personal observation follow. All the cases were rayed and the best examples have been chosen for illustration.

Case 1 (Taylor). Boy, 7, March 1910, right hip. Acute invasion with severe pain in knee. Slight limp since but well and active. One-quarter inch shortening. Motion and röntgenogram characteristic. March 1915: Had short spica about two months. Has been well and active since; slight limp, 60° anteroposterior motion. Röntgenograms show terminal stage, greatly flattened epiphysis which has crept outward over neck until it touches trochanter. One-half inch shortening.

Case 2 (Taylor). Girl, 10, June 1911, left hip, moderate limp last ten months. Joint pain in left knee and now cries in sleep. Trochanter prominent; legs of equal length. Motion and röntgenogram characteristic. Has worn hip splint. March, 1912: Has worn short spicas since last visit until one month ago. Walks with slight limp. No pain. Röntgenogram shows increase in flattening and spreading of epiphysis.

Case 3 (Taylor). Girl, 10, May 1911, right hip. Five years ago began to have lameness and some pain in right hip and knee. No mechanical treatment. Now walks with moderate limp, full flexion in deflected plane, rotation and lateral motion limited. Shortening of ⅝ inch. Röntgenogram characteristic of terminal stage. The photo of the left hip shows a thin, globular epiphysis and thick neck; no symptoms.

Case 4 (Taylor). Boy, 9, September 1913, right hip. Slight lameness began two years ago. Traction in bed three months; then up on crutches and short spica. No pain or trouble since. Legs equal length. Motion to 90° with typical limitation. Walk with slight limp. Röntgenogram typical. Left hip appears normal.

Case 5 (Taylor). Boy, 8, February, 1913, right hip. Very stout boy. Seized with fever and sudden pains in limbs and muscles a year and a half ago. These passed off, leaving slight lameness in right leg and some dull pain in adductor region. Right leg ⅜ inch short. Typical motion, 120°. Röntgenogram showed typical changes. No mechanical treatment. April 1915: No pain for a year. Slight limp; very active.

Case 6 (Taylor). Woman, 40, January, 1910, left hip. At 14 had slight pain in hip and lameness at times for about a year. No mechanical treatment. No trouble after this until the birth of a

Fig. 8. Case 12, right quiet hip; two years' duration; note thin areas in head and neck.

Fig. 9. Case 16, right quiet hip; duration ten months.

Fig. 11. Case 19, left quiet hip; one year's duration.

child ten years ago since when she has had considerable pain about left hip and some lameness; cannot walk far. Left leg is now ½ inch short and adduction is limited. Other movements free. Röntgenogram shows some flattening and mushrooming of head.

CASE 7 (Frieder). Boy, 8, April 1912. Right and left hips. Fell one month ago. No pain. One week ago, gradual onset of right limp. Now no limitation of motion in either hip. Röntgenogram shows flattening of head of right femur; left hip negative. July 1913: short spica last six months. No pain, shortening or limitation of motion. Röntgenogram shows progress of changes in right head and neck; left hip shows beginning changes in neck.

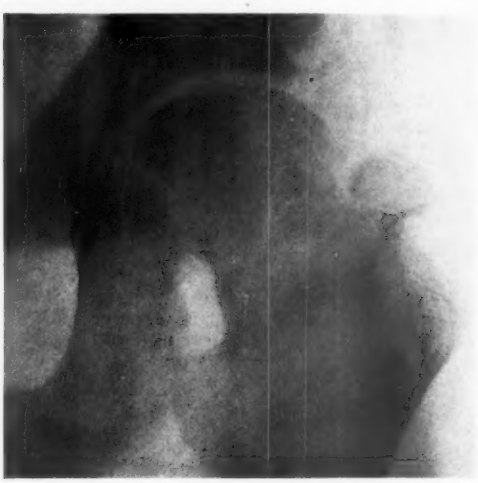

Fig. 10. Case 18, right quiet hip; duration eleven months.

Wassermann and tuberculin negative. October, 1913: Increase of limp and of progressive changes in both hips. No pain or spasm.

CASE 8 (Frieder). Girl, 10, March, 1914, right hip. Gradual onset of limp one month ago. No trauma; no pain. Flexion free, rotation and abduction markedly limited. No shortening. Röntgenogram shows typical changes.

CASE 9 (Frieder). Boy, 6, March, 1915, right hip. Onset, 18 months ago, of lameness with occasional pain in groin. At that time all hip motions free and röntgenogram negative. Limp persists and short spica applied after six weeks. Six months later, röntgenogram showed some flattening of head and roughening along epiphyseal line. All motions slightly restricted. March, 1915: Legs equal; some limitation of lateral motion and flexion. No spasm. Wassermann negative. April, 1915: Röntgenogram shows flattening of head, thickening of neck, and slight coxa vara.

CASE 10 (Roberts). Boy, 6, February, 1914, right hip. Gradual onset of limp without pain a few weeks before. Now ¼ inch shortening, flexion to nearly 90°. Rotation not limited. No spasm. Treatment by brace. Röntgenogram shows progressive flattening and thinning of epiphysis.

The remaining cases were studied at the Hospital for the Ruptured and Crippled in Dr. W. R. Townsend's service except Case 21, which was from Dr. Whitman's service.

CASE 11. Boy, 8, November, 1911, left hip. Three months ago fell from wagon. Four weeks ago, gradual onset of pain in left knee with limp. Now no spasm or pain; little motion. Shortening, ¼ inch. March 1, 1915: Has worn short spicas a part of the time until four months ago. No pain. Flexion and extension free; other motions limited. Legs equal. Trochanter prominent. Slight limp. No complaint. Röntgeno-

Fig. 12. Case 20, right quiet hip; duration nine months. Compare affected with normal side.

gram shows head flat, neck thick, upper side irregular.

CASE 12. Boy, 10, May, 1914, right hip. Acute polyarthritis two years ago with severe pain. All joints recovered except right hip. Pain in hip and limping at times only. Now flexion free, slight limitation of rotation and lateral motion. Right leg ¼ inch short. Röntgenogram shows flattening of head and thickening of neck, also several clear areas in neck. March 31, 1915: Short spicas till March 21. No pain. All motions restricted.

CASE 13. Girl, 6½, August 7, 1914, left hip. June, 1913, pain in left hip; treated for rheumatism in June, 1914, was lame but had no pain. Now, all motions free except rotation somewhat limited. Röntgenogram showed some thickening of neck and irregularity about epiphysis. Short spicas four months. March 8, 1915: Flexion and extension nearly normal; lateral motion good; rotation ¾ of normal. Left leg ¼ inch short.

CASE 14. Boy, 12, December 2, 1914, right hip. Three months ago gradual onset of pain in right knee. Now right limp, 100° of free flexion; marked restriction of rotation with some spasm. Right leg ¼ inch short. Röntgenogram shows slight flattening of head, neck somewhat thickened.

CASE 15. Boy, 8, December 14, 1914, left hip. April, 1913, hit by a wagon; nine months later, occasional pain from pelvis to thigh, with constant slight limp. Now legs equal; flexion free to 75°. Lateral motion and rotation limited. Short spica about six weeks. Röntgenogram shows head slightly flattened, neck thickened and irregular. April 30, 1915: Active; slight limp; pain at times.

CASE 16. Boy, 7, January 14, 1915, right hip. Fell from a wagon eleven months ago and complained of pain in right knee; one month later started to limp; no pain. Short spica nine months. Now ¼ inch lengthening right leg. All motions markedly restricted. Only 5° flexion. Röntgenograms show progressive flattening of head and moderate thickening of neck; some irregularity of epiphyseal line and acetabulum. Left neck somewhat thickened. April 30, 1915: 100° of anteroposterior motion. No complaint.

CASE 17. Girl, 10, March 18, 1915, right hip. Pain and lameness right hip six years ago; plaster spica worn. No treatment past four years. For four months walking with increasing limp; pain in groin. Right leg ½ inch short. Flexion normal. Other motions somewhat limited. Röntgenogram shows head very small, epiphysis very thin, neck short and thick. Left hip normal.

Fig. 13. Case 21, right quiet hip; two years' duration.

CASE 18. Boy, 16, July, 1914, right hip. Two months after a ball game limps a little; no pain; after a time began to have pain and wore a spica two weeks. April 1915: pain and limp disappeared for three months. Since then has limped especially after long walks and it is growing worse; pain on sudden motion. Right leg everted, plane of flexion directed outward, about 30° of antero-posterior motion. Rotation restricted. Röntgenogram shows head flattened, epiphysis thin and opened over top of neck. This has increased markedly since last summer.

CASE 19. Boy, 7, July, 1908, left hip. Slight lameness for past year. Now no pain, little spasm, ½ inch shortening, very mild symptoms. Röntgenograms show head flat, epiphysis very thin and irregular; neck short and thick.

CASE 20. Boy, 5, May 1915, right hip; slight limp nine months; slight pain right knee occasionally after walking. Slight limitation of rotation and abduction; no spasm; ⅜ inch shortening. Röntgenograms show small, flat, irregular epiphysis and thick neck.

CASE 21. Boy, 6, June, 1913, right hip. Large stout boy; no injury. Two years before, began to limp slightly. The right leg is ¼ inch longer. Hip motion is very slightly restricted. No spasm. Has been treated with short plaster spicas. Röntgenogram characteristic; flattened epiphysis and short thick neck.

CASE 22 (Frieder). Boy, 8, July, 1915, right hip. Gradual onset of limp fifteen months ago. Never had any pain or night cries. Legs equal in length. Free flexion to 90°, extension normal; lateral motion restricted in flexion only; no spasm. Röntgenogram shows short, thick neck, flat head, thin, irregular epiphysis divided into two parts by a clear spot, and upper part of adjacent neck irregular. General condition good; walks with slight limp. Treated by short spicas.

CONCLUSIONS

1. Quiet hip disease, osteochondritis of the hip, or Perthes' disease is a distinct morbid entity which should not be confounded with other hip affections.

2. It has characteristic symptoms, röntgenogram, course, and termination.

3. It is benign and not very rare.

4. The treatment is simple and the prognosis good.

5. It is a dysostosis of unknown causation.

6. It is one cause of osteo-arthritis of the hip in adults.

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PRIMARY BENIGN GROWTHS OF THE STOMACH[1]

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THE interest of the profession within recent years has been so centered upon malignant disease of the stomach that little attention has been given to the study of the benign growths that occur in that organ. While the discovery of these latter has in almost all instances been an operative or post-mortem surprise, a careful review of some of the reported cases reveals a number of interesting and important facts concerning their occurrence, diagnosis, and clinical and pathological significance.

Under the designation of benign tumors there are usually included formations such as phantom tumors, hypertrophic and other thickenings of the pylorus, local imflammatory and indurated swellings, aneurisms, and diverticuli of the stomach. The present paper, however, will deal only with the much rarer genuine primary benign growths. These have been but little discussed in the literature and therefore are of far more than usual interest. They include mucous polypi, adenomata, lymphadenomata, myomata, fibromata, lipomata, myxomata, osteomata, and cysts.

From the literature it would appear that benign tumors of the stomach are very rare. Jesse Myer (1) mentions that Tilger could find a record of but fourteen in a series of 3,500 autopsies. This is due, perhaps, to some error in investigation, for Ebstein (2) in 1864 found fourteen stomach polyps alone in 600 necropsies. Many of the cases in actual occurrence are undoubtedly overlooked through erroneous diagnosis and lack of opportunity for operative or autopsic investigation.

Benign tumors may originate in any of the layers of the stomach, may remain restricted to the original layer, or may invade any of the other portions of the viscus. They may form flat, rounded, or nodular intramural masses, or project as pedunculated or sessile tumors into the lumen of the stomach or the peritoneal cavity. Sherren (3) records eighteen cases, the greater number of which were mesoblastic tumors, which projected from the greater and lesser curvatures into the peritoneal cavity; and Orth (4) reports a number of pedunculated lipomata growing from the serosa.

POLYPI

This term is merely descriptive and not histological. The adenomata, fibromata, lipomata, myomata, and papillomata may form polypoid tumors. Sometimes the connective tissue predominates; at other times, the glandular elements.

1. *Mucous polypi.* Microscopically, these are composed of the same tissues as the normal mucosa. According to Fenwick (5), they are really small adenomata that have undergone cystic degeneration. Two types are distinguished by Ménétrier (6): a superficial one involving the excretory ducts and associated with much lobulation and many cysts from the connective-tissue obstruction of the duct; and a deeper form involving the glandular portion mainly, and showing little or no lobulation and few or no cysts. A mixed type occurs also. Polypi may be single or multiple; the latter may number as many as three hundred. To the multiple form the designation of polyadenomata or polyposis has been given. Single mucous polyps are found most frequently near the pylorus and the multiple in the median portion of the stomach. They form soft, slimy, gobular, or more or less lobulated, or even cylindrical or mushroom-shaped tumors attached to the walls of the organ by a thin stalk or pedicle, and varying in size from a wheat grain to several inches in length. A solitary polypus usually measures from one-half to four inches; the multiple seldom exceed three-quarters of an inch in length, are fairly uniform in size, and have been compared to a bunch of grapes. The color varies with the vascularity, from a gray to a deep red brown. The surface is smooth and never adherent.

Reports vary as to the frequency of their

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Fig. 1. W. J. M. Benign pedunculated tumor in the pyloric antrum. Note the mottled appearance of the large circular defect, as if the bismuth were trickling through and around irregular masses.

Fig. 2. G. A. Pedunculated papillomata (benign) in the pyloric antrum. Note the persistent finger-print indentations upon the bismuth shadow in the center of the antrum, not involving either curvatures.

occurrence. Thus, as above stated, Ebstein (2) found them present fourteen times in six hundred autopsies, whereas, in 7,500 autopsies at the Obruchow Krankenhaus only four cases of polypi were discovered, and Fenwick (5) states they did not exceed 0.2 per cent of the London cases.

Regarding the etiology of the gastric polyadenomata, a number of explanations have been advanced but none has been universally accepted. The causes assigned include chronic alcoholism, chronic gastritis, atheroma of the gastric vessels, and other conditions leading to chronic nutritional disturbances of the mucosa. Plausible as these are in individual cases, no one of them would appear applicable to all. The most probable conducive factor is chronic gastritis, which so frequently results in hypertrophic thickening and lobulated swellings of the mucous membrane and finally may lead to the development of smaller or larger polypoid formations. However, Aschoff (7) believes this sequence to be exceptional and that the catarrh is secondary to the polyposis. In this connection, attention may be directed to the association of catarrhal enteritis with polyposis intestinalis and the reported disappearance of the latter after the amelioration of the catarrhal process from colonic irrigation through a cæcostomy opening.

The symptomatology, diagnosis, and treatment will be considered later with those of the other forms of benign tumors.

2. *Adenomata.* These are composed of the same structural elements as are mucous polyps. But while the latter are mainly composed of mucous membrane, true adenomata consist of more or less tortuous, irregularly dilated tubular glands supported by connective tissue and well supplied with blood-vessels. The overlying mucous membrane is affected by chronic interstitial inflammation. The pedunculated variety is most frequently situated in the pyloric region.

Adenomata form rather firm, smooth, round, or somewhat lobulated tumors, occasionally cystic in part, the cyst being filled with brown mucus. They may be single or multiple. When multiple, they rarely attain a larger size than a walnut. Single ones vary greatly in dimensions, the largest recorded being a pedunculated one successfully removed by Chaput (8), which was the size of a fœtal head at term.

A most important fact in connection with adenomata is their close association with carcinomata. Not only is it at times very difficult to differentiate between the two histologically, but even where the microscopical evidence favors benignancy, the clinical course and gross appearance may bespeak a malignant type of disease.

Cases illustrating this point have been reported by Pitt (9), Lange (10), Ferguson (11), and others. The greatest difficulty in histological differentiation, as Aschoff (12) has pointed out, is met with in those intramural, adenomatous tumors which have partly protruded through the submucosa and where the resulting pressure has caused a more solid tubular arrangement of the glandular structures.

3. *Lymphadenomata.* This is a peculiar form of gastric tumor due to an overgrowth of the normal lymphoid tissues. It may develop either in the mucosa, forming numerous polypoid and sessile tumors which project into the lumen and infiltrate the walls of the organ, or it may originate externally in the mesenteric glands and invade the stomach through the serosa. The growth may be widely disseminated and frequently there is a general enlargement of the systemic lymphatic glands similar to that occurring in Hodgkin's disease. The pyloric region appears to be singularly free from these growths. They are soft, smooth, and creamy white, frequently undergoing superficial ulceration or softening at their base, and even gangrene.

Microscopically, they consist of thickened folds of mucous membrane infiltrated with lymphoid elements. The submucous coat is often unaffected.

4. *Myomata.* The pedunculated myomata form single or multiple firm, round tumors varying in size from a pea to a cherry. They are generally found near the pylorus. The intramural form was first described by Morgagni in 1762, since which time more than forty other cases have been recorded. The growth originates in the muscular layer and usually appears as a firm, slowly growing, oval or round, solitary tumor situated near the cardia or at the greater curvature and but seldom in the pyloric region. The size rarely exceeds that of a pea or cherry, but exceptionally there may be enormous lobulated tumors projecting into the stomach lumen or the abdominal cavity beneath the peritoneum. Von Erlach (13) removed a myoma said to have weighed 5,400 grams; von Eiselberg (14) one the size of a man's head; and Kunze (15) a lipomyoma of 251 grams. The submucous variety may undergo cystic and the subserous, sarcomatous degeneration. Microscopically they consist of unstriated muscle-fibers mixed with strands of fibrous tissue.

5. *Fibromata.* These may be single or multiple, and are usually situated in the pyloric region. As a rule they are elongated or club-shaped and measure from 1 to 4 inches in length. Occasionally they assume a globular form. Microscopically they either present a papillomatous structure, or consist entirely of fibrous tissue covered with thin mucous membrane. Fenwick (16) doubts the identity of reported cases of simple intramural fibromata of the stomach. He believes that they are either ordinary scirrhous carcinomata, fibrosarcomata or keloids formed from the scar of a former ulcer. He says: "We have not been able to find a single case in all the literature of a large fibroid tumor of the gastric walls above suspicion."

6. *Lipomata.* The lipomata are very rare, are usually solitary, and are generally situated in the central part of the stomach, on the anterior wall. They originate in either the submucous or subserous coats and, pushing these back, project as small or even very large pendulous masses into the cavity of the viscus or into the abdomen. Very rarely they may be diffused and spread over a large area of the stomach wall. In rare instances they may undergo cystic or malignant degeneration.

7. *Myxomata* are gelatinous, semitransparent tumors, encapsulated in the walls of the stomach and covered by mucous membranes. Only three cases have been published, including one by Hansemann (17).

8. *Osteomata* are really fibromata and sarcomata which have undergone partial ossification. The best known case is that reported by Webster (18) in 1827.

9. *Cysts.* Seven varieties of cysts have been noted. The most common are retention cysts met in obstruction of the mouth of the ducts of the gastric glands in chronic gastritis. Other varieties that have been described are dermoid, serous, hydatid, blood, lymphangiomatous or chylous cysts, and those cysts formed through the degeneration of new-growths.

Symptomatology. The clinical picture presented by this group of tumors varies within the widest ranges from complete euphoria and utter unconsciousness of gastric changes to conditions fraught with grave consequences to health and life. This diversity of manifestations depends largely upon the size, location, and nature of the growth. Intramural growths, of small or even quite large size, located at a distance from the pylorus, may give rise to no appreciable symptoms. Large ones are prone to manifest themselves through their mechanical effects, producing a sense of epigastric weight and dragging. Frequently there are present dyspeptic manifestations of various degrees, loss of appetite, loss of body weight, anæmia, and even pain. Such large growths are usually palpable through the abdominal parietes.

Where the growth is located in the pyloric region, and especially if it be pedunculated, it is more apt to be associated with active dyspeptic symptoms such as have just been mentioned. Epigastric or hypochondriac pains seem to be one of the most constant manifestations. A frequent tendency of pedunculated growths of all types near the pylorus is to prolapse into this opening and cause a partial or complete obstruction. This gives rise to very violent attacks of pain with nausea, retching, and more or less protracted vomiting. Depending upon the degree of obstruction, there result more or less gastric distention, food retention, gastrosuccorhœa and peristaltic rigidity. Frequently there is blood in the vomited matter. The obstruction occurs through a ball-valve action and in most cases is only temporary, the tumor falling back into the stomach and a longer or shorter period of quiescence ensues, to be interrupted again by other attacks of acute obstruction, until finally death or operative interference intervenes. The acute obstructive attack is often the first active manifestation of the disease. Cleghorn (19) reports the occurrence of a pyloric perforation during an attack. This is very rare. More frequent is intussusception. The stomach may be intussuscepted into the duodenum, as in a case recorded by Collier (20), or even the duodenum and part of the stomach into the jejunum, as in Wade's (21) unique case. The tumor in Wade's case was a non-pedunculated fibromyoma near the pylorus.

When the tumor involves the mucous membrane, hæmorrhage is a frequent symptom. It is due to excessive vascularity of the growth or the surrounding mucosa, or to the erosion of a vessel by ulceration or sloughing. The blood may be visible or occult in the stomach contents or stools. As a rule, even though profuse, the hæmorrhage is without serious consequences. Launersh and Klemicke (22) have reported cases in which it proved fatal.

The evidence afforded by the thread test will depend upon the presence or absence of surface oozing, ulceration, or free hæmorrhage. The same remark applies to the demonstration of occult blood in the stools.

It is difficult to formulate rules of diagnosis regarding stomach content examinations aside from the period of acute obstruction. The majority of case reports include no data on this subject. From the few recorded cases and theoretical considerations, we may safely conclude that where the mucous membrane is not involved and there is no obstruction from the growth, normal conditions of motility and secretion should prevail. Where, however, the growth is one essentially of the mucous membrane, as in mucous polyps of the multiple as well as of the single types, achylia has been reported (Myer, 1; Wegele, 23; Chosrojeff, 24; and Campbell, 25). In one of our own patients this was also the case. Myer points out that the achylia is not an ordinary simple one, but is associated with excessive production of mucus of a peculiar character; viz., like egg-white, such as might be expected with great multiplicity of goblet cells. Such a finding, he believes, should always arouse suspicion of a polyposis.

The diagnosis in several cases has been rendered possible by finding a tumor fragment in the vomitus, wash water, or fæces.

The recent rapid development of *radiological diagnosis*, particularly the direct demonstration of anatomical conditions in the stomach, promises to be of more value in the diagnosis of these tumors than any other means short of the actual demonstration of the growth itself. The following three cases illustrate this point:

CASE 1. D. L., male, 73; seen in 1912 with Dr. Max Dantes; suffered for six months from frequent typical acute gall-stone colics, each followed by more or less distinct jaundice. X-ray examination showed the presence of a persistent large, smooth notch on the greater curvature of the stomach. From this the radiographer concluded that a tumor of that organ was present. The patient, who was in active vigorous health, had absolutely no symptoms referable to the stomach other than the nausea or vomiting incidental to his colicy attacks. Subsequent operation by Dr. A. A. Berg revealed a gall-bladder filled with stones and also a papillary adenoma, the size of a walnut, attached to the lesser curvature near the pylorus. The tumor was successfully removed.

CASE 2. W. J. M.,[1] male, 45, entered the Newark General Hospital in January 1915. He had progressively lost in weight and had some indefinite gastric symptoms which might, however, have been attributed to a chronic nephritis from which he suffered. He gave a history of syphilis and had a two-plus Wassermann. A definite movable tumor mass could be made out in the epigastrium. The X-ray examination (see Fig. 1) showed that the mass was located within the stomach, there being a very large, almost circular filling defect at the junction of the antrum pylori and pars media. The defect was characterized by the same mottled appearance that Jesse Myer (1) described in his case of gastric polyadenomata; viz., "as if the bismuth were trickling through and around irregular masses." On opening the abdomen, a pedunculated mass was felt within the stomach not far from the pylorus; this was about 2½ inches in diameter and had its base on the anterior wall. Before the stomach could be incised, the patient collapsed, and after resuscitation no further attempts were made to remove the growth. Since then he has received several intravenous doses of neosalvarsan and injections of mercury. A recent X-ray examination revealed a persistence of the same condition as before, showing no improvement from the specific therapy.

CASE 3. G. A., bridgetender, male, 45, married, was referred to me for diagnosis by Dr. I. M. Popper, in January, 1915. He had been losing in weight, strength, and color for two or three months, despite a very good appetite. He gave a history of years of excessive smoking and beer-drinking and of insufficient food mastication owing to poor teeth. Syphilitic infection was denied. In previous years he often had attacks of acute indigestion, especially after sour or coarse food. Three or four years ago, almost daily, he suffered from severe cramps in the calves of his legs and from chest attacks like angina pectoris, which ceased after discontinuance of tobacco and alcohol. In December, 1913, he had profuse hæmorrhages from the stomach and rectum. Shortly thereafter, he began to have pulling pains, radiating from the umbilicus to the right hypochondrium, especially in bending over his work.

General as well as abdominal examination is negative except for an accentuation of the first heart sound at the apex, a thickening of the radial artery, and a slight rigidity of the upper right rectus. The systole in blood pressure is 165, the diastolic 100. Repeated gastric tests show hypermotility with alkaline contents and a moderate amount of tenacious gastric mucous. The Wolff and Junghan's tests are extremely faint at 1:200. The fæces, both before and after the gastric tests, give very strong occult blood reactions. The Wassermann reaction is negative.

From this history and objective findings, it was difficult to arrive at a definite diagnosis. We had here one of those borderline cases suggesting a number of possibilities, such as ulcer, chronic gastritis, carcinoma, cirrhosis, arteriosclerosis, or syphilis.

To aid in the diagnosis, fluoroscopic and radiographic examinations of the stomach were made. These showed hyperperistalsis and hypermotility of that organ. In both the erect and prone positions there was a persistent unusual defect in the pyloric antrum, giving the appearance of finger prints or indentations upon the bismuth shadow (see Fig. 2). The defect was in the center of the antrum and did not involve either curvature. These radiological findings, together with the clinical factors of the case, led to the diagnosis of a pedunculated tumor within the pyloric antrum, very probably of a benign character, and operation was advised. This was at once performed at the Lebanon Hospital by Dr. Henry Roth.

Externally the stomach appeared normal, but in the pyloric antrum a pedunculated mass could be readily felt. The stomach was opened through a longitudinal incision and two papillomatous growths — one about 1½ by ¾ of an inch and the other ¾ by ½ inch — were found on the posterior wall about three inches from the pylorus. They were radically removed and the bases cauterized with the Paquelin. Sections of the smaller growth showed an entirely benign papillo-adenoma. A piece of mucosa was removed and upon examination was found to be histologically normal. The patient recovered very quickly although a gastric test two months later showed persistence of the achylia.

[1] For the clinical details and the radiogram of this case, I am indebted to Dr. F. C. Baker of Newark, N. J., to whom my thanks are again expressed.

PROGNOSIS

From a purely histological standpoint, the adenomata, fibromata, and myxomata, because of their close relationship to malignant disease, offer the most serious prognosis. However, it is readily apparent from what has been said here and in other literary contributions to the subject, that, despite the benign histological and clinical character of the other tumors of this group, they not infrequently have brought about conditions that resulted in alarming manifestations and sometimes even, despite active medical and surgical intervention, in the death of the patient.

Treatment. Those benign neoplasms that give rise to no symptoms naturally demand no treatment; however, where the diagnosis is established or strongly suspected in other instances, only one procedure is indicated: viz., operative interference and radical removal of the growth. The lamentable inadequacy of internal therapy and the brilliant success of surgical measures have produced a record that speaks convincingly on this point. The suggestion has been made to attempt the gastroscopic removal of those growths not situated in inaccessible portions of the stomach. Aside from the technical difficulties of this procedure, there are several strong objections; namely, the problem of properly controlling the hæmorrhage, the necessity for the removal or thorough destruction of the base of the growth, and the possibility of overlooking other growths that may be present. Laparotomy is so safe, simple, and satisfactory, when properly safeguarded, as to suggest itself as the only adequate procedure in these cases.

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THE CAUSE OF CARCINOMA[1]

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THIS thesis proposes that cancer is caused by a defensive process of the tissue-cells to a great variety of irritations, and that there is no specific external cause for cancer. In carcinoma there is a displacement of active cells of epithelial origin into the mesoblastic tissues. The cells are not of a mature epithelial type but are embryonal in character and irregular in their development. By reason of their displacement, they cannot attain the normal anatomic perfection and physiologic activity of mature cells. Their entire energy is expended in karyokinesis. This karyokinetic energy is developed in the cell as a defensive reaction to the original irritation which, to produce cancer, must also destroy the basement membrane and produce a similar defensive reaction in the connective tissues. In an open wound, whether it be produced rapidly or slowly, we have healing by granulation. The cells of granulation tissue are similar in structure and appearance to embryonal cells. The result of such healing is a scar of imperfectly developed connective tissue covered with epithelium. There is a normal antagonism between cells of mesoblastic origin, and those of epiblastic origin which prevents them from intermingling under the ordinary circumstances of wound healing. If a bit of skin be buried in the subcutaneous tissues it is ordinarily either cast out as a foreign body or destroyed by the action of the phagocytes, or very rarely forms an inclusion cyst which is entirely benign.

To repair a defect caused by a destructive irritant, the tissues produce new cells with all possible rapidity. The defensive reaction to any irritation that falls short of destruction of the cells is an active karyokinesis. The more active this becomes the more nearly the cells approach the embryonal type. The more the normal process of healing is interfered with by a continuance or recurrence of irritation, the more irregular is the mitosis of the cells. This irregularity is a result of the struggle for existence, in which they fail to produce perfect cells. This is true both of the epithelial and connective-tissue cells. The more nearly they come to the embryonal type the more do they lose their antagonism to each other. If Haeckel's postulate, that the development of the individual typifies the development of the species, is true, then we may, perhaps, be permitted to use the simile that these new cells are heterogenous allies fighting a common enemy. Like such allies in the common defense they lose their antagonism to each other and more readily mingle. The common purpose is defense, and this is to be accomplished by new cells to close the gap and protect the tissues. Under ordinary conditions the granulation tissue forms a bed, across which the new epithelial cells are projected, and the defect is closed without any disarrangement of their relative position. At the surface where they belong they attain a satisfactory degree of normal structure and formation. When such healing is continuously interfered with by oft-repeated irritation and that irritation short of destruction is closely balanced with the reparative power of the tissues, then the reproductive power of the cells is enormously increased. We have a readily demonstrable example of this rapid karyokinesis on the part of the leucocytes when an infective attack calls for a greater phagocytic defense. The reproduction of the cells is defensive to the irritation. The greater the demand for defense within certain limits, the more rapid the growth. Under the stress of defense to prolonged irritation the karyokinetic properties of the cells are enormously increased and as this tendency increases they more nearly approach the embryonal type. This is because the chief function of the embryonal cells is growth, and this growth is stimulated in defense to irritation. As the embryonal cells of the epiblast and the mesoblast resemble each other much more closely in form than do the functionating cells of the mature

[1] Read in the Section on Surgery, Seventh Pan American Medical Congress, San Francisco, June 18, 1915.

type, so also in this defensive struggle do they lose their antagonism to each other. They have one common purpose and that is the defense which is accomplished through growth. The energy of the cells is expended in karyokinesis. Repeated interference with the cell growth produces irregular mitosis. The epithelial cell is less differentiated from the new granulation tissue. In this condition the cells mingle and the young epithelial cells become engulfed and lose their proper position on the surface. They thus intermingle with the young cells of mesoblastic origin and the way is opened to them for the infiltration of the surrounding tissues. The environment which makes for a normal development of the cells is lacking. They belong on the surface and cannot in the depths of the tissues attain anatomic perfection and physiologic activity. They retain the excessive karyokinetic tendency of their immediate progenitors and can only grow and reproduce. This tendency, which was at first a defense growth against the irritation which destroyed the basement membrane, now becomes the undoing of the host. In their effort to reach the surface where they belong the young cells with their new-born karyokinetic energy, and with the tolerance for the mesoblastic tissues which they have acquired by contact in the embryonal form, in their defense reaction to the original irritation, continue to grow and disseminate without guidance. The young cells infiltrate the tissues in all directions. The connective tissue thus becomes the stroma of cancer. They invade the lymph-spaces and pass along to the tributary glands producing lymphatic metastases. They crowd upon each other and so devitalize the tissues that pressure degeneration and ulceration occur, and we have the open ulcerated cancer.

Pathologists have searched, but so far in vain, for some common cause of external origin for cancer. It will not be necessary for us to name for you the bacteria and protozoa that from time to time have claimed this place. The filterable virus of certain mouse and chicken tumors is suggestive only of a single irritating substance that provokes a defensive reaction in the tissues. The growth of nut-galls on the oak is only a similar defensive karyokinesis to a chemical irritant injected by the gall-fly.

Let us follow the history of some well-know types of cancer and see if we can discover a greater probability of a specific external cause than of the tissue defense karyokinesis that we have outlined. This picture is reproduced in smokers' cancer of the mouth, where the long-continued effects of cresote and other products of slow combustion, plus other irritants, give first a leucoplakia and later a destructive ulceration which breaks down the basement membrane and gives ingress to the overstimulated epithelial cells that have been reduced to the embryonal type. It is the same in the mouth cancer of the betel-nut chewers of Java, who mix lime with the leaves in forming their favorite quid. Here is an irritant of an entirely different type producing the same result. In the lip cancer of pipe smokers we see a combination of traumatic, thermic, and chemical irritations from the pressure of the hot stem plus the irritation of the smoke. In chimney sweep's cancer we have again the irritating effect of creosote and other smoke products as the destructive agent. Now such agents are not favorable to the development of microbic or protozoan enemies to the tissues. They should truly inhibit such invaders. They are all irritants that call for tissue defense by cell multiplication.

In Thibet in the winter the natives wear small charcoal stoves to keep the hands and body warm, much as the women of our country wear fur muffs. Cancer of the abdominal wall is not uncommon among them. The long-continued frequently repeated thermic irritation of the abdominal wall in time produces ulceration that finally gives rise to the displacement of the rapidly growing epithelial cells. In their struggle to cover the frequently disturbed base of granulation tissue, they lose their connection with the margin and are submerged in the new cells of mesoblastic origin. Can we in such a cancer reasonably expect to find some specific external cause that might also be operative in cancer of the cervix? We think not. One condition is common to both—a destructive

irritation from widely different agents that sets up a defense reaction in the cells; the one from a dry heat irritation, the other from the irritation of uterine discharges plus frictional irritation of a thin scar over a lacerated structure of complex contour.

Our knowledge of the physical effects of radiation as a destructive agent to the tissues of the body is comparatively recent. Unfortunately for the victims who were the early examples of the destructive effects of the röntgen ray, the application was painless. Long exposure with the inefficient primitive apparatus for the purpose of making radiographs was sometimes followed by frightful ulceration of a most destructive character, painful, and slow to heal. In the frequently repeated slighter and, as we know now, unnecessary exposures of the hands of X-ray operators chiefly in examinations with the primitive hand fluoroscope, the early workers produced dermatitis, telangiectasis, and keratosis, which were all distinctly defensive reactions to the irritation. When these failed in their defense by reason of the frequent attacks of the destructive force, conditions for the downward migration of growing epithelium were present and cancer resulted. More than a score of X-ray workers have lost their lives and many more have lost fingers or hands from cancer. Surely there can be no other explanation of the etiology of such cancers.

In the senile keratoses of the hands and face which are sometimes followed by superficial epithelioma, may we not have an example of the destructive agency of light? They occur chiefly on parts exposed to light. It is fair to assume that in addition to other irritations incident to exposure, the pernicious effect of continued irritation by light radiation is an important factor in their development.

Does the theory of Cohnheim find a place for reasonable application in these radiation cancers? We think not. Certainly we found displaced cells of epiblastic origin in the mesoblast. They are embryonal and irregular in character. It is not more reasonable to conclude that in such situations they have found lodgment in their new location as a result of defensive reaction to the special irritation than that they were developed from embryonal rests.

In our discussion of the probability of cancer being caused by some specific agent of external origin, let us contrast these radiation cancers with cancer of the stomach. What single external cause might be operative in such widely diverse conditions? It is agreed that in stomach cancer, ulceration can be frequently demonstrated as the base on which cancer forms, not the base of the ulcer, although this part would be most exposed to infection, but the margin where the young cells from both sides of the basement membrane are making their struggle for existence. Let the cause of the ulceration be what it may, of the many that have been proposed, where else in the body have we conditions more subject to repeated irritation than the tissues surrounding a gastric ulcer in the pyloric region? Is it not reasonable to find in this a cause for the great frequency of cancer of the pylorus? We have here both traumatic and chemical irritants: the traumatism of the peristaltic wave in crowding the stomach contents over on ulcerated area; the chemical irritation of the digestive fluids and of toxines of bacteria associated with the ulceration.

When these irritations are overwhelming in their character the tissues are defeated in their defense and a perforated ulcer results. When, however, they are so balanced with repair that defensive action of the tissue-cells is enabled to prevent this by an active karyokinesis, we have ideal conditions for the admixture of the rapidly growing cells which the defensive process fosters.

The complex structure of the mammary gland favors the isolation of small portions of gland tissue. The efferent ducts may become occluded either through a chronic mastitis having its origin in a pyogenic infection during lactation, or through the fissures of the nipple that mark the beginning of Paget's disease. Such extensions may also begin with the involutional changes of the climacteric, or those attendant on nutritional disorders, manifested first as cystic breast. In such a state a single trauma may be the active agent in producing the disturbance of the gland structure that is presently followed

by a chronic irritation from retained autogenous secretion that calls forth the defensive karyokinesis of the tissue-cells.

Here also the invasion of the mesoblastic tissues may be favored by the direct pressure of the retained secretions.

What other explanation than the effects of chronic irritation producing a defensive reaction in the tissue-cells can there be for the various cancers of the colon and rectum. Their common site is the dependent flexures where fæcal accumulation takes place. The cæcum, the middle of the transverse colon, the dependent flexure of the sigmoid, the rectum, are in connection with pressure of irritating contents subject to the primary lesions that favor the defensive cell reaction which leads later to the infiltration of cancer.

These examples, it is believed, are sufficient to illustrate the fact that in tissues widely divergent in location and function a great variety of irritations, traumatic, thermic, radiant, or chemical—and this includes such substances as lime and creosote as well as the toxins of bacteria—may be followed by cancer. This does not argue well for any possible specific external cause. The only condition present in all is a defense reaction on the part of the cells. That defense is first manifest in the production of new cells.

It is only where long-continued or repeated irritation destroys the basement membrane and unduly stimulates a defensive karyokinesis, that the adjacent mesoblastic and epiblastic cells lose their antagonism for each other and mingle, that the invasion of the mesoblastic tissues by immature epiblastic cells takes place, and a cancer is formed.

THE ORIGIN OF RETROPERITONEAL CYSTIC TUMORS

By MURRAY N. HADLEY, M.D., F.A.C.S., Indianapolis, Indiana

A CONSIDERABLE amount of speculation has been done in an attempt to explain the origin of the so-called chyle cysts of the abdomen. Rokitansky, Moynihan (2), and Dowd (1) have each offered theories. Clinical contributions reviewing the literature and reporting new cases of these curious tumors have appeared with relative frequency in the past five years, so that there has accumulated a rather complete discussion of the subject.

It is my purpose to offer an additional suggestion in explanation of the genesis of certain of these cystic tumors. It seems more than probable that the group of abdominal tumors generally classed as chylous cysts do not all have the same origin. The only way we have of determining the nature of a cystic tumor is by a study of its life history, its location, the structure of its wall, and the character of its contents. By these criteria chyle cysts of the abdomen vary so widely that it seems hardly logical to ascribe a common mode of origin.

The cystic tumors whose origin is herein discussed are retroperitoneal in location, are not lined with epithelium, and the fluid content may or may not be chylous in character. Reference to the embryological development of the lymphatic system it seems to me, points the way rather conclusively to a proper understanding of the origin of this group of tumors as well as of the origin of the more frequent cystic tumors in the lateral regions of the neck, known as hydrocele of the neck, or hygroma.

The most recent investigation (3) divides the development of the lymphatic system into two stages. The primary stage consists of the development of a series of isolated lymph-sacs, which are clearly derived from the veins, and which later become united by the thoracic duct which connects these sacs with each other. The secondary stage involves the peripheral growth of lymphatic vessels which sprout out from the endothelial lining of these sacs and spread over the body.

The process of development from the

lymph-sac to the adult lymph-node is as follows: The lymphatic sacs by a process of bridging or cutting of the lumen by bands of connective tissue are transformed into a plexus of lymphatic capillaries out of which chains of lymph-nodes are evolved. If this development of a particular lymph-node was arrested at a stage when it was still a plexus we would have the basis for the development of a future cyst. It is some abnormality of the first stage of development in these primitive lymphatic sacs that seems to me to offer an explanation of the origin of the retroperitoneal cystic tumors, as well as the hygromata of the neck.

These primitive lymphatic sacs are four in number; the jugular sacs located in the neck, the retroperitoneal sac located in the abdomen opposite the lower dorsal and upper lumbar vertebra, and the posterior sacs located in the pelvis.

The neck hygromata always seem to arise in the vicinity of the carotid sheaths, the exact location of the primitive jugular lymph-sacs. The origin of these tumors has been ascribed to dilated lymph-spaces, but it seems strange that if such be the origin they do not develop elsewhere. No epithelium appears in the tumor wall and the fluid content is serous or chylous in character.

Likewise the retroperitoneal cystic tumors, of which the report of a case follows, develop at a point corresponding in location to the primitive retroperitoneal lymph-sac. The walls of these tumors are also not lined with epithelium and the contents may be serous or chylous in character.

The close similarity of these two groups of tumors is strongly suggestive of a common origin, and also the fact that they arise at points corresponding to primitive lymph-sacs points strongly to these structures as the genesis of their origin.

A mechanic, 48 years old, married. Family and past history negative as to present illness.

Present illness. One and a half years ago he noticed a bulging of the abdomen above and to the left of the umbilicus. He was not disabled and continued his work. In March 1911, he consulted a physician who aspirated about two quarts of a milky white fluid. This operation was repeated in June 1911, September 1911, December 1911, and August 1912. The second, third, and fourth tappings yielded about one and one-half gallons of a yellowish fluid which he described as chicken fat in color. In August 1912, when I first saw the patient, he was poorly nourished, his complexion was sallow, and he had an expression not unlike that of the "facies ovariana" of the old writers.

There was no œdema of the feet or dilatation of abdominal veins. The lungs were clear, heart enlarged to two inches beyond nipple line, and there were present both diastolic and systolic murmurs.

He presented a symmetrical abdominal enlargement extending from lower thorax aperature to symphysis. Palpation revealed a smooth, tightly distended abdominal wall, perfectly symmetrical and slightly tender. The percussion note was universally flat all over the abdomen in any position the patient would take, except in the right flank and over the epigastrium, at which points it was tympanitic.

Operation. The exploration revealed an enormous cystic tumor which filled the entire peritoneal cavity, reaching from the symphysis below to the ribs above. The base of the tumor was found to rest against the posterior abdominal wall, beneath the peritoneum, extending from an inch to the right of the vertebræ to within one inch of the left kidney. The tumor was easily removed and with but a very small amount of hæmorrhage.

The post-operative history was uneventful until the twelfth day after the patient had been sitting up in bed, when he suddenly began to vomit. He died two days later with symptoms of acute gastric dilatation.

Histologic examination of tumor wall: The structure of the wall of the tumor was fibrous, noncellular resembling connective tissue. There was no epithelium present on the inner wall. No chemical examination was made, unfortunately, of the contents, but it was noted as being of a chocolate brown color.

CONCLUSION

This tumor and cystic hygromata in the neck originate in the same embryological structures, that is the primitive lymphatic sacs. The evidence of this is found in the fact that the histological structure of the wall in tumors of these two groups is similar, neither being lined with epithelium. The physical characteristics would indicate a similarity in their contents, and finally both groups arise at points where there previously existed the primitive lymph-sac.

REFERENCES

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3. Florence Sabin. Human Embryology by Keibel and Mall, ii.

GUNSHOT WOUNDS OF THE ABDOMINAL CAVITY[1]

With Report of Cases

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GUNSHOT wounds of the abdominal cavity, whether they penetrate any of the hollow viscera or not, place the individual in danger of his life. Such injuries usually occur in strong and healthy persons, and all cases demand an exploration of the abdominal cavity. I wish to report eighteen cases as follows:

Case 1. C. D., male, age 21, American, white, was admitted to Mercy Hospital, March 23, 1901. He had received a gunshot wound produced by a revolver of a large caliber.

Condition on admission. Shocked, intermittent pulse of 80, features pinched; tender over abdomen; muscles rigid; peristalsis active. The wound of entrance was located in the back, one-half inch above the iliac crest and three inches to the left of the spinal column. The bullet could be palpated under the skin just below the costal margin to the right of the sternal line.

Operation. Laparotomy performed about four hours after injury.

Pathology. There was much blood in the abdominal cavity. There were two perforations in the jejunum, twelve and thirteen inches respectively from the duodenum. The serosa of the jejunum was torn in one place and there was one perforation of the jejunal mesentery. The perforations were closed by silk sutures. The abrasions of the serosa of the bowel were sutured and the opening in the mesentery closed. The blood was removed from the abdominal cavity by sponging. A glass drain was inserted for drainage and the incision closed. The bullet was removed by a separate incision. The patient recovered and was discharged from the hospital April 30, 1901.

Case 2. J. C., male, age 20, Italian, white, was admitted to Mercy Hospital, March 5, 1903. He had received a gunshot wound produced by a revolver of small caliber.

Condition on admission. General condition fair. Abdomen rigid and tender. The wound of entrance was on the left side of the abdomen near the umbilicus, on a line drawn from the navel to the anterior superior spine. The bullet went through the abdominal wall obliquely to the right.

Operation. Laparotomy was performed about two hours after injury.

Pathology. There was some blood in the abdominal cavity. There were eleven perforations in small intestines. The perforations were closed by silk sutures. The abdominal cavity was sponged free of blood. A large glass drain was inserted and the incision closed.

There was more or less drainage of the character of blood serum, having the colon odor. During the convalescence an abscess developed in the right inguinal region. This was opened and about one pint of pus evacuated. The bullet was found at the bottom of this cavity. The patient recovered and was discharged May 2, 1903.

Case 3. J. T., male, age 20, American, white, was admitted to the Mercy Hospital, May 31, 1905. He had received a gunshot wound produced by a revolver.

Condition on admission. General condition fairly good. Pulse 114, some shock. There was some tenderness of the abdomen and rigidity of the abdominal muscles. The wound of entrance was on the right side, just above the border of the ribs, one inch internal to nipple line.

Operation. Laparotomy; time of operation not recorded but was same day as injury.

Pathology. The abdominal cavity contained much blood. A lacerated wound of the quadrate lobe of the liver was found. There was no other injury to abdominal contents. The blood was removed from the abdominal cavity by sponging. The wound of the liver was packed and the incision closed. The patient recovered and was discharged June 27, 1905.

Case 4. A. L., male, age 35, Polish, white, was admitted to Mercy Hospital, July 4, 1906. He had received a gunshot wound produced by a 32-caliber revolver.

Condition on admission. General condition fair, pulse 90, and of fair volume. The abdomen was rigid in the upper part. There was tenderness in upper part of the abdomen; peristalsis was diminished. The wound of entrance was about two inches to the right of umbilicus.

Operation. Laparotomy performed about seven hours after injury.

Pathology. The omentum had protruded through the bullet wound. An incision was made through the right rectus, and the omentum was cleansed and dropped back into abdominal cavity. No perforations were found. There was a small wound with a hæmatoma in the mesentery of the small intestine. Considerable brown serous fluid of sweet odor was present in the abdominal cavity. The incision was closed. Streptococci were found in the fluid removed from the abdomen.

Death occurred the next day, July 5, 1906.

Case 5. J. C., male, age 27, Italian, white, was admitted to Mercy Hospital, February 2, 1907.

[1] Read before the Allegheny County Medical Society, May 18, 1915

He had received a gunshot wound of the abdomen produced by a 32-caliber revolver. He was about 40 feet distant from the gun when the accident occurred.

Condition on admission. Temperature 100.2°, pulse 112. No evidence of shock. The abdominal muscles, were rigid and somewhat tender. Peristalsis was present. The wound of entrance was one inch outside the mid-clavicular line, between the sixth and seventh ribs.

Operation. Laparotomy performed four hours after accident.

Pathology. There was some clotted blood in the abdominal cavity. There were no perforations of the abdominal contents. The incision was closed with drainage. He recovered and was discharged from the hospital March 6, 1907.

CASE 6. E. G., female, age 22, American, white, was admitted to the Mercy Hospital, September 2, 1907. She had received a gunshot injury produced by a 32-caliber revolver.

Condition on admission. Pulse 116, general condition fair. Respirations rapid. The wound of entrance was in the mid-clavicular line, right side, opposite xiphoid cartilage. The bullet had been removed by a small incision in the posterior axillary line, left side, just below angle of scapula. Crepitation could be felt around posterior wound. The abdomen was rigid, tender, and somewhat dull in the flanks.

Operation. Laparotomy performed six hours after injury.

Pathology. There was a fracture of the sternal end of the seventh rib, on the right side. About one-half pint of blood was found in the abdominal cavity. The left pleura was opened. No perforations were found nor injury to the liver. The incision was closed and the abdominal cavity drained through Douglas' pouch.

Several days later there was a fæcal discharge through the wound where the bullet had been removed. The fæcal matter was well digested. This discharge continued for some time. In this case it is evident that the bullet went into the abdominal cavity and out through the diaphragm on the left side, and in its progress went through the splenic flexure of the colon. However, at the time of operation no injury to any hollow viscus could be found. The patient recovered and was discharged October 5, 1907.

CASE 7. Male, age 13, American, white, was admitted to the Mercy Hospital, December 4, 1907. He had accidently been shot while attempting to load a 22-caliber rifle. The bullet entered on the right side of the abdomen taking a course downward and backward.

Condition on admission. General condition fair. The abdomen was rigid and tender.

Operation. Laparotomy was performed six hours after injury.

Pathology. There were two perforations of the sigmoid. These were closed by silk sutures. The incision was closed with drainage. The patient recovered and was discharged from the hospital December 22, 1907.

CASE 8. M. W., male, age 28, American, white, was admitted to the Mercy Hospital, February 16, 1908. He received a gunshot wound produced by a revolver of large caliber. He was three feet from the gun when the accident occurred. He walked a short distance to a physician's office who immediately brought him to the hospital in a trolley car, a distance of 30 miles.

Condition on admission. Pulse 100, abdomen slightly distended. The abdominal muscles were rigid and tender, peristalsis was absent. The wound of entrance was under the left costal margin, above and to the left of the umbilicus in the mid-clavicular line.

Operation. Laparotomy performed five hours after injury. Median incision above umbilicus.

Pathology. The abdominal cavity contained a large amount of dark blood. There were two perforations of the stomach: one in the anterior wall about two inches from lesser curvature and almost in the center of fundus; the other in posterior wall, slightly lower than in the anterior wall. There were two perforations of the transverse colon; one in anterior wall opposite the mesentery, the other in the posterior wall at the attachment of the mesentery. There was one perforation of the transverse mesocolon. The perforation of the anterior wall of stomach and the anterior wall of transverse colon were closed in the usual manner. The perforation in posterior wall of stomach and the perforation in posterior wall of transverse colon were closed after going through the gastrocolic omentum. All perforations were closed with silk sutures. An opening was made just above the pubes, for drainage. A rubber tube was inserted into the lesser peritoneal cavity and several pieces of gauze to site of perforations. The incision was closed. The patient recovered and was discharged from the hospital March 10, 1908.

CASE 9. S. A., male, young adult, Italian, white, was admitted to Mercy Hospital, September 28, 1908. He received a gunshot wound produced by a 32-caliber revolver. He was six feet away from the gun.

Condition on admission. Slight shock. Abdominal muscles rigid. Tender over abdomen. Peristalsis absent. The wound of entrance was in the right semilunar line above level of umbilicus.

Operation. Laparotomy was performed about twelve hours after injury. An incision was made through the right rectus.

Pathology. Two large perforations were found in the small intestines, middle portion. The openings were opposite one another. There was marked inflammation of the intestines at site of the perforations. The bowel was resected for the reason that to close the openings would have occluded the lumen of the bowel. An end-to-end anastomosis was done. Sutures were first inserted through all

coats of the bowel over which a continuous Lembert suture was introduced through serosa and muscular layers. The opening in the mesentery was closed. Silk sutures were used throughout. The abdominal incision was closed with drainage.

On November 1, a mass was palpable in the lower left side of abdomen extending two inches above Poupart's ligament. Rectal examination revealed a mass in the pelvis extending up to the left. A rectal speculum inserted and proctotomy performed. Through this opening about one pint of pus escaped. The patient recovered and was discharged from the hospital November 18, 1908.

CASE 10. M. P., male, age 15, Italian, white, was admitted to the Mercy Hospital, February 8, 1910. He had received a gunshot wound produced by a revolver.

Condition on admission. Abdominal muscles tender and rigid. Not much peristalsis. The wound of entrance was just above the costal cartilage of the ninth rib on the right side and above the level of the umbilicus.

Operation. Laparotomy was performed the same day of injury.

Pathology. Much blood mixed with intestinal contents was present in the abdominal cavity. Two perforations were found in the transverse colon near the hepatic flexure. There was a small wound in the mesentery of the small intestine. The bullet was free in the abdominal cavity. An incision was made through the right semilunar line. The openings in transverse colon were closed by inverting the bowel. The abdominal cavity was cleansed by sponging and the incision was closed. Two drainage tubes were inserted; one above pubic bone, and the second in right loin. The patient died February 8, 1910. Autopsy revealed peritonitis to be the cause of death. No other perforations were present.

CASE 11. M. D., female, age 21, Italian, white, was admitted to the Gill Hospital, Steubenville, Ohio, under the care of Dr. J. C. M. Floyd, July 29, 1910. She had received a gunshot wound produced by a revolver.

Condition at time of operation. Expression good. Pulse 120, slight elevation of temperature. Abdomen distended, slightly rigid all over abdomen and tender to pressure. Peristalsis very poor. The wound of entrance was just above Poupart's ligament, two and one-half inches from midline, on right side.

Operation. Laparotomy performed fifty-seven hours after injury. Incision made a little to the right of midline between umbilicus and pubes.

Pathology. Diffuse peritonitis, much pus in right iliac fossa. One perforation of the cæcum. The bullet evidently made just one opening. A second incision was made through the semilunar line on the right side and an artificial anus established through the perforation. The cæcum could not be brought up to the original incision. The cæcum was anchored to the peritoneum with silk. A small tube was inserted to the bowel for drainage and the midline incision closed. A colpotomy was done to establish drainage and a small tube was inserted into Douglas' pouch. The patient made a good recovery from the injury and operation, but died August 15, 1910. Dr. Floyd informed me that the abdominal symptoms had at this time entirely cleared up and that the cause of her death was due to septicæmia.

CASE 12. J. Q., male, age 41, American, negro, was admitted to Mercy Hospital, September 27, 1910. He had received a gunshot wound produced by a revolver.

Condition on admission. General condition poor, muscles of the abdomen rigid and tender to pressure. The wound of entrance was just above ninth rib, left side.

Operation. Laparotomy performed seven hours after injury. Incision was made in the midline between the xiphoid and umbilicus.

Pathology. Gas and considerable blood in the abdominal cavity. One small opening was found in the transverse mesocolon. Two perforations were found; one in anterior wall of pylorus, the other in posterior wall, directly opposite. The perforations were large enough to admit the end of a finger. An opening was found in the gastrocolic omentum from which there was free bleeding. The perforation in the anterior wall of the pylorus was closed. The opening in the transverse mesocolon was enlarged and the perforation in the posterior wall of pylorus closed; silk sutures being used for both. The opening in the transverse mesocolon was closed, leaving, however, a drainage tube in the lesser peritoneal cavity. Drainage was inserted to the anterior wall of the stomach, at the site of perforation. A glass drain was inserted to pelvis and the incision closed. The patient died the same day evidently from shock.

CASE 13. E. M., male, age 12, American, white, admitted to Sewickley Valley Hospital, under the care of Dr. DeWitt B. Nettleton, December 17, 1910. He had received a gunshot wound of the abdomen produced by a 22-caliber Flobert rifle.

Condition on admission. Much shock, abdomen slightly distended, muscles rigid and tender to pressure. Peristalsis lost. The wound of entrance was just below the border of the ribs, right side, one and one-half inches from midline.

Operation. Laparotomy was performed four hours after injury.

Pathology. Large amount of blood was present in abdominal cavity, one quart at least. A good-sized blood-vessel was found bleeding in the gastro-hepatic omentum. I thought at the time this was the hepatic artery but later I concluded that it was a branch. There was a slight abrasion of the surface of the liver where the bullet had passed between the liver and the stomach. The liver was slightly lacerated near its posterior margin. The lesser peritoneal cavity contained blood. No perforations were found.

An incision was made in the midline between the

xiphoid and umbilicus. The bleeding vessel was controlled. The abdominal cavity was sponged free of blood. The laceration of the liver was sutured. A drainage tube was inserted to the pelvis through a small incision just above pubes and the incision closed. The patient made a good recovery.

CASE 14. A. J., male, age 29, American, negro, was admitted to Mercy Hospital, March 19, 1911. He had received a gunshot wound produced by a revolver.

Condition on admission. General condition fair but somewhat shocked. The abdominal muscles were rigid and tender to pressure. Peristalsis was absent. The patient also had several incised wounds of the head. The wound of entrance was in the upper left quadrant of the abdomen on a level with the umbilicus.

Operation. Laparotomy was performed eleven hours after injury.

Pathology. In the lower part of the ileum was a ragged laceration, almost completely dividing, the bowel, with a tear in the mesentery two inches long. A little higher in the ileum, on opposite sides of the bowel, two perforations were found both large enough to admit the finger end. Between these two points of injury to the bowel the mesentery was badly injured. The appendix had been amputated by the bullet one inch from base. Its mesentery was not injured. There was also a wound of the mesocæcum two inches long, opening up the retrocæcal space. The abdomen was full of blood.

An incision was made through the left rectus. The blood was removed from the abdominal cavity and the injured bowel searched for and found. On account of the extensive injury to the bowel, it was necessary to resect eighteen inches of it. After closing the end of the bowel a lateral anastomosis was done. The perforations higher in the ileum were closed. A lateral anastomosis was performed here also, for the reason that the lumen of the bowel was almost occluded. The remainder of the appendix was removed and the stump inverted. The holes in the mesentery were also closed. A drainage tube was inserted to the pelvis and drainage established to the site of the bullet wound. The incision was then closed. The patient did not react and died the same day as operation.

CASE 15. P. K., male, age 35, American, white, was admitted to the Mercy Hospital, December 11, 1911. He had received a gunshot wound produced by a revolver of a large caliber.

Condition on admission. General condition good. Abdomen rigid, especially in right upper quadrant, with some tenderness in that region. Peristalsis present. The wound of entrance was just below the costal margin on the right side, just below the border of the ribs.

Operation. Laparotomy performed two hours after injury.

Pathology. Abdominal cavity contained a large amount of liquid and clotted blood. The course of the bullet was downward and outward, where it struck the tenth costal cartilage and fractured it. There was no injury to any abdominal organs.

An incision was made through the right rectus. The blood was removed from the abdominal cavity by sponging, and a thorough examination was made. A drainage tube was inserted through the loin on the left side on a level with the anterior superior spine, and the incision was closed. On January 21, 1912, the bullet was found under the skin in the back, between the ribs and the crest of the ilium. He recovered and was discharged from the hospital January 27, 1912.

CASE 16. H. C., male, age 17, American, white, was admitted to the Mercy Hospital, August 11, 1913. He had received a gunshot wound of the abdomen produced by a 25-caliber revolver.

Condition on admission. Markedly shocked. The abdominal muscles were very rigid and there was tenderness all over abdomen. No peristalsis. The wound of entrance was two or three inches below the crest of the ilium on the right side, the course of the bullet being upward.

Operation. Laparotomy performed about seven hours after accident.

Pathology. The abdominal cavity was full of blood. There were four perforations in the lower part of the jejunum and five perforations in the lower part of the ileum.

An incision was made in the midline. The perforations in the jejunum were closed by silk. The lumen of the bowel was much occluded and a lateral anastomosis done, short circuiting the fæcal current. All perforations of the ileum were closed except one. This was brought to the incision and anchored to the peritoneum, forming an artificial anus. Drainage was instituted to pelvis and the remainder of incision closed. The patient developed a severe peritonitis and died August 13, 1913.

CASE 17. Male, age 46, American, white, was admitted to the Markleton Sanatorium, June 11, 1914. He received a gunshot wound of the abdomen produced by a shotgun loaded with about No. 2 shot.

Condition on admission. Bad general condition with much shock. Abdominal muscles very hard with tenderness all over abdomen. Some peristalsis. Wounds of entrance: there were seven or eight wounds of the abdomen which entered the abdominal cavity. He received also other wounds of the body, mostly of the legs.

Operation. Laparotomy performed fourteen and one-half hours after injury.

Pathology. Abdominal cavity contained small amount of blood. There were sixteen perforations found in the small intestines. The perforations were below the middle of the jejunum, scattered all along the ileum, to within one foot of the ileocæcal valve. The perforations were small. There was some injury to the mesentery of the small bowel.

An incision was made in the midline below the umbilicus. The perforations were found and closed.

coats of the bowel over which a continuous Lembert suture was introduced through serosa and muscular layers. The opening in the mesentery was closed. Silk sutures were used throughout. The abdominal incision was closed with drainage.

On November 1, a mass was palpable in the lower left side of abdomen extending two inches above Poupart's ligament. Rectal examination revealed a mass in the pelvis extending up to the left. A rectal speculum inserted and proctotomy performed. Through this opening about one pint of pus escaped. The patient recovered and was discharged from the hospital November 18, 1908.

CASE 10. M. P., male, age 15, Italian, white, was admitted to the Mercy Hospital, February 8, 1910. He had received a gunshot wound produced by a revolver.

Condition on admission. Abdominal muscles tender and rigid. Not much peristalsis. The wound of entrance was just above the costal cartilage of the ninth rib on the right side and above the level of the umbilicus.

Operation. Laparotomy was performed the same day of injury.

Pathology. Much blood mixed with intestinal contents was present in the abdominal cavity. Two perforations were found in the transverse colon near the hepatic flexure. There was a small wound in the mesentery of the small intestine. The bullet was free in the abdominal cavity. An incision was made through the right semilunar line. The openings in transverse colon were closed by inverting the bowel. The abdominal cavity was cleansed by sponging and the incision was closed. Two drainage tubes were inserted; one above pubic bone, and the second in right loin. The patient died February 8, 1910. Autopsy revealed peritonitis to be the cause of death. No other perforations were present.

CASE 11. M. D., female, age 21, Italian, white, was admitted to the Gill Hospital, Steubenville, Ohio, under the care of Dr. J. C. M. Floyd, July 29, 1910. She had received a gunshot wound produced by a revolver.

Condition at time of operation. Expression good. Pulse 120, slight elevation of temperature. Abdomen distended, slightly rigid all over abdomen and tender to pressure. Peristalsis very poor. The wound of entrance was just above Poupart's ligament, two and one-half inches from midline, on right side.

Operation. Laparotomy performed fifty-seven hours after injury. Incision made a little to the right of midline between umbilicus and pubes.

Pathology. Diffuse peritonitis, much pus in right iliac fossa. One perforation of the cæcum. The bullet evidently made just one opening. A second incision was made through the semilunar line on the right side and an artificial anus established through the perforation. The cæcum could not be brought up to the original incision. The cæcum was anchored to the peritoneum with silk. A small tube was inserted to the bowel for drainage and the midline incision closed. A colpotomy was done to establish drainage and a small tube was inserted into Douglas' pouch. The patient made a good recovery from the injury and operation, but died August 15, 1910. Dr. Floyd informed me that the abdominal symptoms had at this time entirely cleared up and that the cause of her death was due to septicæmia.

CASE 12. J. Q., male, age 41, American, negro, was admitted to Mercy Hospital, September 27, 1910. He had received a gunshot wound produced by a revolver.

Condition on admission. General condition poor, muscles of the abdomen rigid and tender to pressure. The wound of entrance was just above ninth rib, left side.

Operation. Laparotomy performed seven hours after injury. Incision was made in the midline between the xiphoid and umbilicus.

Pathology. Gas and considerable blood in the abdominal cavity. One small opening was found in the transverse mesocolon. Two perforations were found; one in anterior wall of pylorus, the other in posterior wall, directly opposite. The perforations were large enough to admit the end of a finger. An opening was found in the gastrocolic omentum from which there was free bleeding. The perforation in the anterior wall of the pylorus was closed. The opening in the transverse mesocolon was enlarged and the perforation in the posterior wall of pylorus closed; silk sutures being used for both. The opening in the transverse mesocolon was closed, leaving, however, a drainage tube in the lesser peritoneal cavity. Drainage was inserted to the anterior wall of the stomach, at the site of perforation. A glass drain was inserted to pelvis and the incision closed. The patient died the same day evidently from shock.

CASE 13. E. M., male, age 12, American, white, admitted to Sewickley Valley Hospital, under the care of Dr. DeWitt B. Nettleton, December 17, 1910. He had received a gunshot wound of the abdomen produced by a 22-caliber Flobert rifle.

Condition on admission. Much shock, abdomen slightly distended, muscles rigid and tender to pressure. Peristalsis lost. The wound of entrance was just below the border of the ribs, right side, one and one-half inches from midline.

Operation. Laparotomy was performed four hours after injury.

Pathology. Large amount of blood was present in abdominal cavity, one quart at least. A good-sized blood-vessel was found bleeding in the gastrohepatic omentum. I thought at the time this was the hepatic artery but later I concluded that it was a branch. There was a slight abrasion of the surface of the liver where the bullet had passed between the liver and the stomach. The liver was slightly lacerated near its posterior margin. The lesser peritoneal cavity contained blood. No perforations were found.

An incision was made in the midline between the

xiphoid and umbilicus. The bleeding vessel was controlled. The abdominal cavity was sponged free of blood. The laceration of the liver was sutured. A drainage tube was inserted to the pelvis through a small incision just above pubes and the incision closed. The patient made a good recovery.

CASE 14. A. J., male, age 29, American, negro, was admitted to Mercy Hospital, March 19, 1911. He had received a gunshot wound produced by a revolver.

Condition on admission. General condition fair but somewhat shocked. The abdominal muscles were rigid and tender to pressure. Peristalsis was absent. The patient also had several incised wounds of the head. The wound of entrance was in the upper left quadrant of the abdomen on a level with the umbilicus.

Operation. Laparotomy was performed eleven hours after injury.

Pathology. In the lower part of the ileum was a ragged laceration, almost completely dividing, the bowel, with a tear in the mesentery two inches long. A little higher in the ileum, on opposite sides of the bowel, two perforations were found both large enough to admit the finger end. Between these two points of injury to the bowel the mesentery was badly injured. The appendix had been amputated by the bullet one inch from base. Its mesentery was not injured. There was also a wound of the mesocæcum two inches long, opening up the retrocæcal space. The abdomen was full of blood.

An incision was made through the left rectus. The blood was removed from the abdominal cavity and the injured bowel searched for and found. On account of the extensive injury to the bowel, it was necessary to resect eighteen inches of it. After closing the end of the bowel a lateral anastomosis was done. The perforations higher in the ileum were closed. A lateral anastomosis was performed here also, for the reason that the lumen of the bowel was almost occluded. The remainder of the appendix was removed and the stump inverted. The holes in the mesentery were also closed. A drainage tube was inserted to the pelvis and drainage established to the site of the bullet wound. The incision was then closed. The patient did not react and died the same day as operation.

CASE 15. P. K., male, age 35, American, white, was admitted to the Mercy Hospital, December 11, 1911. He had received a gunshot wound produced by a revolver of a large caliber.

Condition on admission. General condition good. Abdomen rigid, especially in right upper quadrant, with some tenderness in that region. Peristalsis present. The wound of entrance was just below the costal margin on the right side, just below the border of the ribs.

Operation. Laparotomy performed two hours after injury.

Pathology. Abdominal cavity contained a large amount of liquid and clotted blood. The course of the bullet was downward and outward, where it struck the tenth costal cartilage and fractured it. There was no injury to any abdominal organs.

An incision was made through the right rectus. The blood was removed from the abdominal cavity by sponging, and a thorough examination was made. A drainage tube was inserted through the loin on the left side on a level with the anterior superior spine, and the incision was closed. On January 21, 1912, the bullet was found under the skin in the back, between the ribs and the crest of the ilium. He recovered and was discharged from the hospital January 27, 1912.

CASE 16. H. C., male, age 17, American, white, was admitted to the Mercy Hospital, August 11, 1913. He had received a gunshot wound of the abdomen produced by a 25-caliber revolver.

Condition on admission. Markedly shocked. The abdominal muscles were very rigid and there was tenderness all over abdomen. No peristalsis. The wound of entrance was two or three inches below the crest of the ilium on the right side, the course of the bullet being upward.

Operation. Laparotomy performed about seven hours after accident.

Pathology. The abdominal cavity was full of blood. There were four perforations in the lower part of the jejunum and five perforations in the lower part of the ileum.

An incision was made in the midline. The perforations in the jejunum were closed by silk. The lumen of the bowel was much occluded and a lateral anastomosis done, short circuiting the fæcal current. All perforations of the ileum were closed except one. This was brought to the incision and anchored to the peritoneum, forming an artificial anus. Drainage was instituted to pelvis and the remainder of incision closed. The patient developed a severe peritonitis and died August 13, 1913.

CASE 17. Male, age 46, American, white, was admitted to the Markleton Sanatorium, June 11, 1914. He received a gunshot wound of the abdomen produced by a shotgun loaded with about No. 2 shot.

Condition on admission. Bad general condition with much shock. Abdominal muscles very hard with tenderness all over abdomen. Some peristalsis. Wounds of entrance: there were seven or eight wounds of the abdomen which entered the abdominal cavity. He received also other wounds of the body, mostly of the legs.

Operation. Laparotomy performed fourteen and one-half hours after injury.

Pathology. Abdominal cavity contained small amount of blood. There were sixteen perforations found in the small intestines. The perforations were below the middle of the jejunum, scattered all along the ileum, to within one foot of the ileocæcal valve. The perforations were small. There was some injury to the mesentery of the small bowel.

An incision was made in the midline below the umbilicus. The perforations were found and closed.

The blood in abdominal cavity was removed by sponging and the incision was closed after placing a drain in pelvis. The patient died the next day after operation, evidently from shock and peritonitis.

CASE 18. D. J. S., male, age 50, American, white, was admitted to the Ohio Valley Hospital, Steubenville, Ohio, under the care of Dr. Curtiss Laughlin, October 28, 1914. He had received two gunshot wounds produced by a 38-caliber revolver.

Condition on admission. General condition good. Slight shock. Abdominal muscles were very rigid with tenderness all over abdomen. Some peristalsis. Blood pressure 100. Wounds of entrance: one a little to the left of umbilicus, the other on a level with the anterior superior spine, midway between the crest of the ilium and ribs, on the right side.

Operation. Laparotomy performed 2 hours and 40 minutes after injury.

Pathology. The abdominal cavity contained between one and two pints of blood. There were seven perforations in the lower part of ileum, within three feet of one another. The part of bowel was probably six feet from the ileocæcal valve. One of the perforations was three-fourths of an inch long. There were two perforations in the mesentery. Two of the perforations were at the mesenteric attachment. The sigmoid in one place was abraded, the abrasions evidently being produced by the bullet. The parietal peritoneum in the right iliac fossa was perforated.

A midrectus incision was made on the right side, on a level with the umbilicus. The blood was removed from the abdominal cavity by sponging, and a search made for the perforations. The perforations were all closed. The lumen of the bowel was not obstructed at any place. The abrasion of the sigmoid was inverted. Two drainage tubes were inserted; one just above the pubes to the pelvis the other through the entrance of bullet wound in right loin.

During operation 2,000 ccm. normal salt solution was given intravenously. Convalescence was fair but the patient had some complications during this time. Two days after the operation he developed acute dilatation of the stomach, which was relieved by lavage. The patient also developed symptoms of obstruction, causing a great deal of concern. Fortunately all the symptoms cleared up and he recovered.

The general recovery percentage for the eighteen cases is 61.11. In these eighteen cases only thirteen had perforations of the hollow viscera with seven recoveries, giving a recovery percentage of 53.84. Five cases did not have any injury to any part of the intestines. Of this number four recovered.

The perforations occurred in all parts of the intestinal tract, from the stomach to the sigmoid inclusive, except the duodenum. The greater number of perforations in any one case was sixteen. The time of operation after injury in those cases which recovered was from two to twelve hours. In those cases in which death occurred the time of operation after injury was from seven to fifty-seven hours. The average time of operating after injury in those who recovered was about five or six hours; for those who died the average time was about seventeen hours. A definite conclusion cannot be drawn from this series, but I believe that if an operation is performed within the first six hours there would be many more recoveries.

The symptoms of gunshot wounds of the abdominal cavity are quite frank and vary but little in every case. All that is necessary to make a diagnosis is the rigidity of the abdominal muscles, tenderness of the abdomen to pressure, and the wound of entrance. The tenderness is possibly more acute in the region of the wound. There are also other symptoms present such as shock, more or less severe, with its accompanying pallor, increase of pulse rate, vomiting, etc. Peristalsis is also diminished or absent. Distention of the abdomen is usually late. Dullness may be present resulting from hæmorrhage. These symptoms are common also to any intraperitoneal perforation of any of the abdominal viscera from disease.

The treatment is entirely operative and should be done early. After opening the abdomen all that is necessary to do in most instances is to close the perforations, remove all blood from the abdominal cavity, introduce drainage, and close the incision. It will be necessary occasionally to resect a portion of the bowel for extensive injury to the bowel itself or its mesentery. Lateral or end-to-end anastomosis can be done. An artificial anus can also be established. This procedure is valuable where the operation is late and peritonitis is advanced. After closing a perforation in the small bowel, if it is found that the lumen is too much or entirely occluded, an entero-enterostomy can be done. This will avoid a resection and save much time. The opening should be made near to the closed perforation. The best way to close the perforation, in my opinion,

is first to appose the edges of the opening by silk sutures which go through all the coats of the bowel and then introduce a continuous Lembert suture of the same material which takes in only the serous and muscular coats. This method makes but little narrowing of the lumen of the bowel.

Many complications follow these injuries. Shock comes first. It immediately follows the accident. Hæmorrhage when it occurs is a close second. Other complications occur. Peritonitis is always present. Threatened obstruction of the bowel and acute dilatation of the stomach should be kept in mind. These complications require appropriate treatment. The hæmorrhage is controlled at the time of operation. The treatment for peritonitis need not be described for it is well known. Threatened obstruction of the bowel deserves much consideration.

Russian oil in good-sized doses with enemata given at regular intervals has given good results in my hands. Acute dilatation of the stomach demands immediate attention. The diagnosis should be made early. The signs to be looked for are irritability of the stomach causing regurgitation or slight emesis and the dilatation of the stomach. This should easily be discovered.

In these cases of gunshot wounds of the abdomen I have always noted that the concavity existing normally at the intercostal angle has disappeared and is replaced by a fullness or convexity when acute dilatation of the stomach develops. If this condition is left untreated it will go from bad to worse. Lavage is the treatment. Two or three washings of the stomach may entirely relieve the complication but treatment must be instituted early to get this result.

THE PHYSIOLOGICAL METHOD OF TENDON TRANSPLANTATION[1]

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I. Historical; Anatomy and Physiology of Tendons

I REFER here not to the free transplanting of a tendon but to the transference of its point of insertion in such a way as to alter the function of a muscle. A rational system of tendon transplantation must be based upon an accurate knowledge of the anatomy and physiology of tendons and muscles. That our present systems are empyric rather than rational is shown by the marked discrepancy in the operative methods of prominent orthopedic surgeons. Thus Lange[2], on the basis of over 2,000 tendon operations, is radically opposed to Vulpius whose experience is almost as great. Lange insists upon the periosteal implantation of the transplanted tendon first advocated by Drobnik, and lengthens the tendon artificially by silk strands. Vulpius maintains the advantages of sewing the transplanted tendon to the paralyzed tendon, the method first advocated in 1882 by Nikoladoni. Lange sutures the tendon under the greatest possible tension, Vulpius under moderate tension, Stoffel without any tension whatever. Lange draws the tendon through the fatty subcutaneous tissues, Vulpius beneath the fascia. The discrepancies in the after-treatment are equally marked. Thus Lange advocates six weeks' fixation, whereas Putti begins to exercise the transplanted tendon several days after the operation.

These divergent views do not concern inconsequential details but the essentials of the operation. It is evident that a tendon transplantation differs radically from a finished surgical procedure, such as a gastro-enterostomy; in the latter, despite slight differences of method, all surgeons are agreed as to the essentials, whereas in the tendon transplantation scarcely a single principle in the operative procedure can go unchallenged.

In these papers I wish to report the result of studies in the anatomy and physiology of tendons, conducted during the past 2 years in the experimental department of the Oskar-Helene Home for Crippled Children, Berlin, and to suggest a series of tendon operations based upon these studies. The essential principle of many of these operations was published in 1910 by Professor Biesalski, the director of the hospital, and it was with his co-operation that the final operative technique has been formulated. I am deeply indebted to Professor Biesalski for his encouragement and for the opportunity to test clinically the practical effectiveness of the operations. The anatomical dissections and the animal experiments were performed in the Pathological Department of the municipal Urban Hospital, Berlin, whose director, Dr. M. Koch, freely placed all the facilities of his department at my disposal.

THE HISTORY AND PLAN OF THE RESEARCH

These studies had their inception during the winter of 1912. Professor Lange of Munich, in whose clinic I was then serving, finding that the results of many tendon transplantations were impaired by post-operative adhesions, urged the need of experimental work to determine the method of preventing these adhesions. I assisted Dr. Henze, of New Haven, in the attempt to solve this problem. We tested successively the effect of ensheathing the tendon operated upon, with fat, fascia, veins, cartilage, vaseline, thin tubes of rolled silver, and Cargile membrane. In all instances except with the Cargile membrane the adhesions proved firmer than where nothing was inserted to prevent their formation. The Cargile membrane, though giving better results than the other substances, did not act effectively to prevent adhesions.

An excellent means, however, proved to be the technique employed by Biesalski: the utilization of the sheath of the paralyzed tendon as a simple physiological means of

[2] See bibliography at end of third paper.

[1] This article is the first in a series of papers on "Tendon Transplantation." The other two articles will appear in subsequent issues.

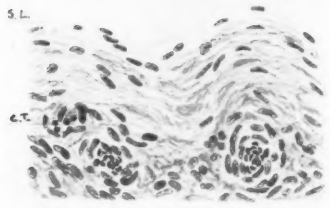


Fig. 1. Microscopical longitudinal section through the upper pole of the sheath of the flexor longus hallucis (adult). Van Gieson stain. Leitz obj. 5, oc. 4, tube 140. *S.L.* Synovial layer; *C.T.* vascular connective tissue. The section shows the microscopical characteristics of the wall of the sheath: (1) the thin synovial lining, consisting of a single layer of cells, irregularly distributed, in a finely fibrillar almost homogeneous matrix, which, with "Van Gieson" is stained violet; (2) the subjacent coarsely fibrillar vascular connective-tissue layer, which above the sheath is continuous with the paratenon of the tendon.

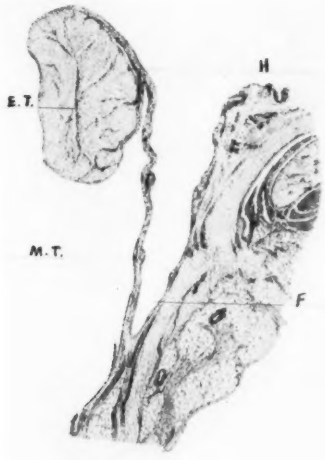


Fig. 2. Microscopical cross section of the tendon of the tibialis anticus (8 months infant) 0.5 cm. above the intermalleolar line. Leitz obj. 1, oc. 0, tube 140. Previous to fixation, the sheath had been slit open, the tendon lifted out so as to stretch the mesotenon, and was held in this position during fixation. The section demonstrates the relation between the tendon hilus, mesotenon, and floor of the sheath. *E.T.* Endotenon; *M.T.* mesotenon; *F.* floor of the sheath; *H.* hilus of the tendon.

avoiding adhesions. The paralyzed tendon is withdrawn from the sheath, the transplanted tendon drawn through the sheath in its place. *Our animal experiments proved conclusively the correctness of Biesalski's clinical observations; in six instances of tendon suture and in three of tendon transplantation, examination of specimens removed 4 to 30 days after operation showed the complete absence of adhesions.*

This clear-cut experimental evidence in favor of the principle of Biesalski's operation indicated the advisability of thoroughly investigating its potentialities and perfecting its technique. In his procedure I saw not merely a means of preventing adhesions, but a principle of radical importance: that of adopting the operation to the normal anatomy and physiology of tendons. Every detail of the operation should be made consistent with the anatomical and physiological facts. The method of fixing the tendon, the degree of tension given it, the line of traction — all should conform to the normal. It became evident, however, as soon as I tried to follow out this line of thought that our conception of the normal is still hazy.

The physiology of tendon motion, traction, and tension has never been investigated. I found that we had been talking glibly about the gliding of a tendon without any accurate conception of how a tendon glides; about the tension of a tendon without any conception of how great the tension normally is. Even the anatomical facts were, I found, not sharply defined. The conceptions of the tendon sheath, the relation between the peritenon and the sheath, between mesotenon and peritenon, the vascular supply of tendons and many of the details of the finer anatomy of tendons and their related structures were loose and vague. It was therefore necessary, before attempting to formulate an operative technique, that these basic facts be investigated.

The plan of study resolved itself into four main divisions:

I. The general conceptions of tendon anatomy and physiology with the following sub-headings:

1. The relation of the tendon to its sheath, the fascia, and the surrounding loose connective tissues.
2. The blood supply of tendons.
3. The mechanism of the gliding of tendons.

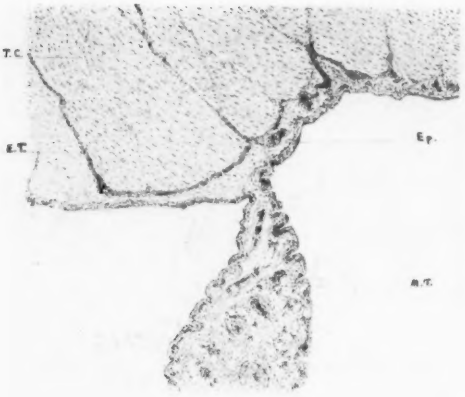


Fig. 3. Microscopical cross section through the hilus of the extensor longus hallucis tendon (adult). Leitz obj. 3, oc. 1, tube 140. *T.C.* Tendon cells; *E.T.* endotenon, *Ep.* epitenon; *M.T.* mesotenon.

The mesotenon expands at its insertion into the tendon, forming a delicate tightly adherent connective-tissue enveloping layer—the epitenon. From the epitenon, connective-tissue septa extend into the tendon, separating it into larger and smaller bundles. These septa I have termed the endotenon (old terminology: peritenonium internum), as opposed to the esotenon, the connective tissue coating the surface of the tendon. Within the sheath the esotenon is represented by the epitenon and the mesotenon; above the sheath and at the two portals of the sheath by the paratenon.

4. The tension of tendons.

II. The anatomy and physiology of each individual tendon.

III. The application of these facts to the technique of tendon transplantations.

IV. The experimental and clinical results.

I. General Conceptions of Tendon Anatomy and Physiology

1. *The tendon sheath and the connective-tissue structures associated with the tendon.*

The term tendon sheath is frequently loosely applied. The surgeon often speaks of a sheath of the Achilles tendon or of the semitendinosus tendon, although no true sheath is present. The sheath, properly conceived, corresponds to a joint in that it is a sharply circumscribed cavity containing a synovia-like fluid. It is found whenever a tendon at some phase of its motion is forced to turn a corner. When a tendon pursues a straight course, no sheath is found. Sometimes when a tendon changes its direction, no sheath is present, as in the instance of the quadriceps and patella tendons. Here, however, the knee-joint takes the place of the sheath. The object of the sheath is evidently to act as a fluid buffer where the tendon rubs against bone or ligament. It does not give the tendon an increased range of motion, since the tendon glides as freely above the sheath as within it. A tendon sheath differs from a bursa only in its degree of development: therefore the line of differentiation between the two is difficult to determine. The sheath, when fully developed, completely encloses the tendon, the bursa protects a relatively small portion of the circumference of the tendon. Many sheaths, however, fall far short of completely enclosing the tendons, e.g., that of the peroneus tertius, whereas some bursæ, as that of the flexor carpi radialis, line more than half the circumference of the tendon.

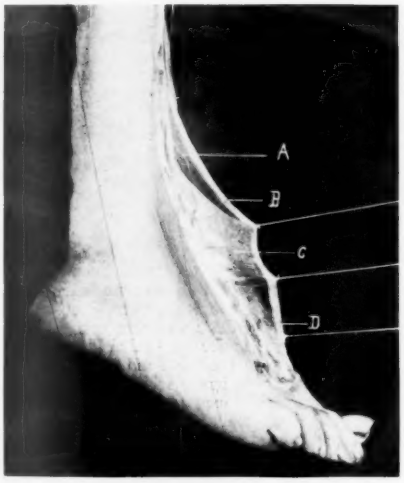


Fig. 4. Photograph of the extensor proprius hallucis tendon of an adult. The sheath has been opened, the fascia above and below incised, and the tendon lifted out of its bed. *A*, The lowermost muscle-fibers. *B*, the upper limit of the sheath; *C*, the mesotenon, stretched to the maximum width 4 cm.; *D*, lower pole of the sheath.

Retterer, the French embryologist, claims that the sheath is not a sharply defined structure, that it is not closed at its ends, but merges with the connective tissue, of

Fig. 5. The tendon of the tibialis posticus, after injecting the vessels with gelatin-cinnabar. The tendon has been lifted out of the sheath so as to demonstrate the proximal and distal vincula, and the anastomosing blood-vessels, which ramify on the deep surface of the tendon. This tendon is regularly without a mesotenon.

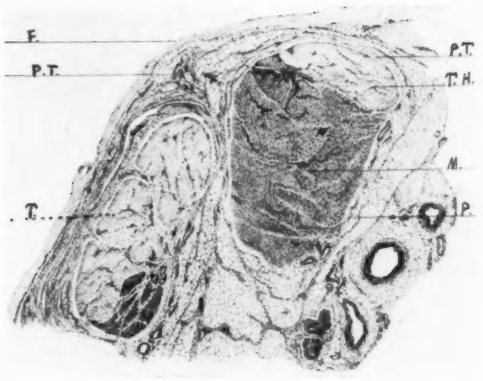


Fig. 6. Microscopical cross-section through the tendons of the extensor proprius hallucis and extensor longus digitorum (6 months infant) 1.5 cm. above the intermalleolar line. Leitz obj. 1, oc. 1, tube 140. *F.* Fascia; *P.T.* paratenon; *T.* tendons of the extensor longus digitorum; *T.H.* tendon extensor propius hallucis; *M.* muscle; *P.* perimysium.

The section shows the tendons above the upper pole of their sheaths, where they are enveloped by loose, fatty connective tissue—the paratenon. The paratenon is continuous with the perimysium and adventitia of the blood-vessels. It fills out all the crevices of the fascial compartment, and by means of its elasticity allows the tendon to move freely.

which it is but a differentiated part. My injection experiments and microscopical sections bring me to an opposite conclusion. They show clearly that, with rare exceptions, the sheath is closed at both ends by a very thin, definite lining membrane. This membrane is easily ruptured when fluid is injected into the sheath under pressure, and when infection has occurred within the sheath it cannot offer any barrier to its spread.

The wall of the sheath, corresponding to that of a joint, is lined with a layer of cells, which we may term synovial. They are probably modified connective-tissue cells developed from the undifferentiated embryonal connective tissue, which surrounds the fœtal tendon. The usual fixation methods cause the cell protoplasm to shrink, so that in microscopical sections (Fig. 1) one sees only irregularly shaped and irregularly placed nuclei lying in a finely fibrillar, almost homogeneous matrix, which with the Van Gieson stain is sharply differentiated from the coarser fibers of the subjacent, very vascular connective tissue. The synovial layer is, however, not a complete lining of the sheath. Just as the hyaline cartilage of the joint is not everywhere coated with a synovial layer (Fick, *Anatomie der Gelenke*), so in some portions of the sheath I could find no evidence of a synovial lining. The synovial layer may be firmly adherent to the outer fibrous layer of the wall of the sheath, or between the two may be interposed fatty areolar tissue.

The mesotenon. When the sheath of a tendon is opened and the tendon lifted out, a delicate connective-tissue membrane is seen connecting the tendon with the floor of the sheath. This structure, known as the mesotenon, transmits blood-vessels to the tendon and corresponds roughly to the mesentery of the intestine (Fig. 2). That portion of the tendon into which it is inserted is termed the *hilus*. It is always on the surface of the tendon least exposed to friction. Here the connective tissue of the mesotenon expands on the surface of the tendon, forming the *epitenon*, and sends connective-tissue strands between the tendon bundles, this forming the *endotenon*.[1] (Fig. 3). When

[1] Old terminology: peritenonium internum.

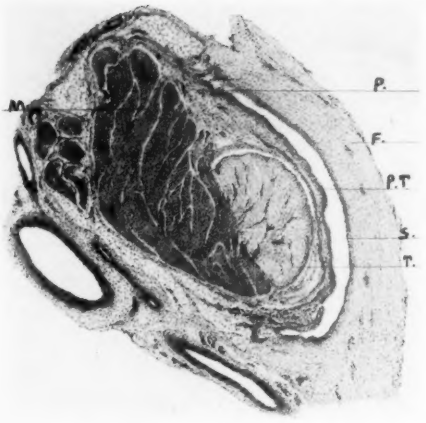


Fig. 7. Microscopical cross section through the tendon of the extensor proprius hallucis (6 months infant) 1.0 cm. above the intermalleolar line. Leitz obj. 1, oc. 1, tube 140. *P.* Perimysium; *F.* fascia; *P.T.* paratenon (plica); *S.* tendon sheath; *T.* tendon; *M.* muscle.

The section is taken through the upper pole of the sheath, seen here as a cleft between the fascia and the paratenon. The tendon, therefore, on entering the sheath is not suddenly divested of its loose connective-tissue envelope. This accompanies the tendon for a variable distance within the sheath and forms the plica.

stretched to the maximum, the mesotenon of the extensor proprius hallucis tendon is 3 to 4 cm. wide at the level of the malleolus

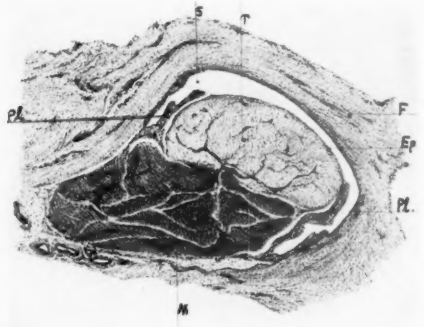


Fig. 9. Microscopical cross section through the tendon of the extensor proprius hallucis (6 months infant) at the level of the intermalleolar line. Leitz obj. 1, oc. 1, tube 160. *Pl.* Lateral prolongation of the plica; *S.* tendon sheath; *T.* tendon; *F.* fascia; *Ep.* epitenon; *M.* muscle.

Here the tendon lies free within the sheaths. The plica is still visible as a fold on each side of the tendon; these form its lateral prolongations (Figs. 11 and 12) by means of which it is inserted into the mesotenon.

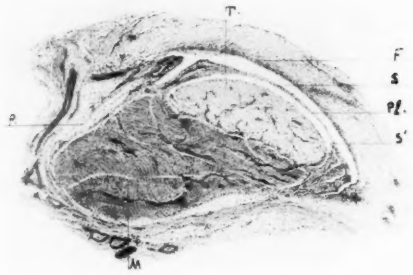


Fig. 8. Microscopical cross section through the tendon of the extensor proprius hallucis (6 months infant) 0.5 cm. above the intermalleolar line. Leitz obj. 1, oc. 1, tube 160. *P.* Perimysium; *F.* fascia; *S.* superficial pocket of the sheath; *Pl.* plica; *S'.* deep pocket of the sheath; *M.* muscle; *T.* tendon.

The cleft representing the sheath is seen to be divided into a superficial and a deep compartment by a connective-tissue partition. Serial sections as well as the corresponding longitudinal section show this to be continuous with the paratenon of Fig. 7. The formation of two compartments is due to the doubling of the plica on itself (therefore the term plica duplicata) whereby it forms a tongue-like projection into the sheath.

(Fig. 4). Nearer the insertion of the tendon its width rapidly diminishes for reasons which will be discussed when we consider the mechanism of the gliding of a tendon. The mesotenon is continuous with the connective tissue surrounding the tendon above and below the sheath. When the tendon is al-

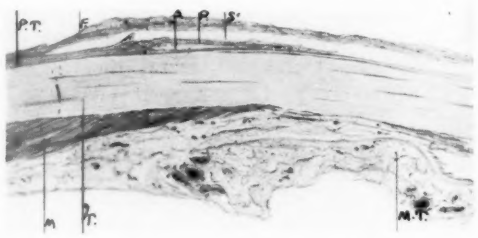


Fig. 10. Microscopical longitudinal section through the tendon of the extensor proprius hallucis (adult) at its entrance into the sheath. Magnification: X 10. *PT.* Paratenon; *F.* fascia; *S.* deep pocket of the sheath; *P.* plica; *S.* superficial pocket of the sheath; *M.* muscle; *T.* tendon; *M.T.* mesotenon.

This section enables us to correlate the preceding cross sections (Figs. 6, 7, 8, and 9). The paratenon, the loose connective tissue between the tendon and the fascia, above the sheath forms a tongue-like projection into the sheath, which is thus divided at its upper pole into a deep and a superficial pocket. The rôle of the plica in the mechanics of tendon motion is discussed under the "Physiology of Tendons."

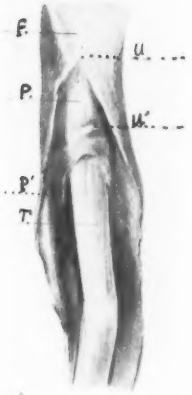


Fig. 11. Dissection of the upper pole of the sheath of the tibialis anticus (adult), anterior view. *F.* Fascia; *P.* plica; *P'.* lateral prolongation of the plica; *T.* tendon free in the sheath; *U.* upper limit of the superficial pocket; *U''.* upper limit of the deep pocket.

The fascial wall of the sheath has been incised until the superficial pocket of the upper pole of the sheath has been fully exposed. The plica is thus laid bare. The deep pocket of the sheath between plica and tendon, is indicated by folds of the plica. The lateral prolongations of the plica shown microscopically in cross section (Fig. 9) are here seen macroscopically.

lowed to drop back into place the mesotenon adapts itself to its narrow quarters by forming numerous folds, which cover the floor of the sheath. The mesotenon differs radically in one respect from the mesentery: it may be absent. Thus the tendon of the tibialis posticus is always without a mesotenon: the flexor longus hallucis tendon in 70 per cent of the specimens examined, the flexor longus digitorum tendon in 50 per cent. When the mesotenon is absent, it is represented at each end of the sheath by a short membrane which, depending upon its shape, may be termed a *vinculum triangulare* or *quadrangulare*. Usually in addition to these vincula there are one or more fine strands connecting the tendon with the sheath, *vincula filiformia*. These residual mesotena are usually coupled to one another on the surface of the tendon corresponding to the hilus by a thin band of connective tissue in which the blood-vessels ramify (Fig. 5).

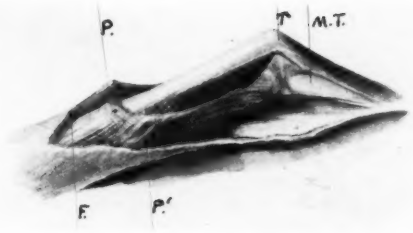


Fig. 12. Dissection of the upper pole of the sheath of the tibialis anticus (adult), lateral view. *P.* Distal margin of the plica; *T.* tendon; *M.T.* mesotenon; F. incised fascia; *P.'* lateral prolongation of the plica.

The specimen demonstrates the lateral prolongations of the plica and their insertion into the mesotenon. Compare with Figs. 9 and 10.

The paratenon. When a tendon is examined above the level of the sheath it is seen to be surrounded by fatty areolar tissue, which completely fills all the interstices of the fascial compartment, in which the tendon is situated (Fig. 6). This areolar tissue is continuous with the perimysium, the perineurium, and the adventitia of the blood-vessels. It is of paramount importance, as we shall see later, in the gliding of the tendon, for, like the mesotenon, its elasticity enables it to stretch several centimeters without tearing its attachment to the tendon. For this connective tissue, usually known as the peritenonium externum, I suggest the term *paratenon*, so as to distinguish it from the connective tissue coating the tendon within the sheath, for which the term *epitenon* is proposed. Epitenon and paratenon constitute the *esotenon* as opposed to the *endotenon* (usually termed the peritenonium internum), the connective tissue separating the tendon bundles. For all the connective-tissue structures associated with the tendon, the old term *peritenon* may well be employed.

The exact mode of entrance of a tendon into its sheath is of importance in understanding the mechanism of tendon motion. Not all tendons behave in the same way. Hartmann was the first to note that some tendons are enclosed by a connective-tissue envelop for some distance within the sheaths, whereas others are without such a connective-tissue covering. Hartmann's observations, though macroscopically correct, are not accurate

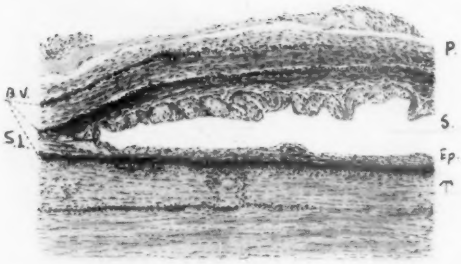


Fig. 13. Microscopical longitudinal section of the tendon and the plica through the deep pocket of the sheath of the extensor proprius hallucis (adult). For orientation (see Fig. 16). Leitz obj. 3, tube 170. *B.V.* Blood-vessels; *S.L.* synovial layer; *P.* plica; *S.* deep pocket of the sheath; *Ep.* epitenon; *T.* tendon.

The plica consists of a vascular connective-tissue core and an external synovial layer, which is, however, not always present (see Fig. 15). At the point of reflection to the tendon, the external layer of the plica is prolonged downward on the surface of the tendon as the epitenon.

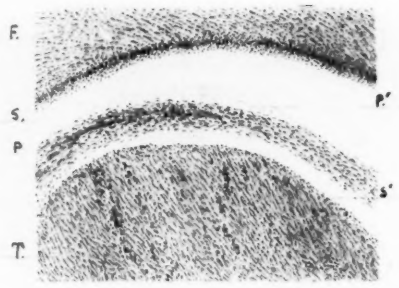


Fig. 15. Microscopical cross section through the tendon, plica, and fascial wall of the sheath of the extensor proprius hallucis (6 months infant) 0.5 cm. above the intermalleolar line. (The same specimen as in Fig. 8 more highly magnified) Leitz obj. 3, oc. 1, tube 160. *F.* Fascia; *S.* superficial pocket of the sheath; *P.* plica; *T.* tendon; *P.'* irregular surface of the plica, synovial cells absent; *S.'* deep pocket of the sheath.

The synovial layer of the plica is not a well-developed histological entity, since it is frequently, as in this section, absent.

when microscopically controlled, for then it is evident that every tendon, without exception, on entering the sheath is enveloped by connective tissue. Only in the case of some tendons this tissue is better developed and is doubled on itself to form a fold — *the plica*.

Fig. 14. Microscopical longitudinal section of the fascia, paratenon and tendon through the superficial pocket of the sheath of the extensor proprius hallucis (adult). For orientation see Fig. 16. Leitz obj. 3, oc. 1, tube 170. *S.L.* Synovial layer; *P.T.* paratenon; *F.* fascia; *S.* superficial pocket of the sheath; *P.* plica adherent to the tendon, *T.*

The vascular paratenon, situated between fascia and tendon above the sheath is prolonged downward into the sheath as the plica. The plica therefore naturally has the microscopical and physiological characteristics of the paratenon, and is, like the paratenon, peculiarly adapted to the gliding of the tendon. The synovial lining of the fascial wall of the sheath is reflected to the surface of the plica.

The entrance of a tendon into the sheath is best understood by studying a series of microscopical cross sections taken about one-fourth inches apart through the extensor proprius hallucis and correlating them with the corresponding longitudinal sections. In Fig. 7 it is evident that the cleft representing the proximal pocket of the sheath lies not between tendon and fascia, but between the connective tissue covering the tendon, that is, the paratenon, and the fascia; in other words the tendon is covered by connective tissue in the proximal portion of the sheath. The second serial section, Fig. 8, shows two clefts separated by a connective-tissue partition, the plica; while in the third (Fig. 9) the connective tissue has disappeared and the tendon lies free in the sheath. The corresponding longitudinal section (Fig. 10) gives us a clearer conception of the somewhat complicated relations. There we see that this connective tissue, the plica, is continuous with the paratenon and forms a tongue-like projection into the sheath, at the upper pole adherent to the tendon, further distal separated from the tendon by a pocket of the sheath. Thus the proximal portion of the sheath is divided into two

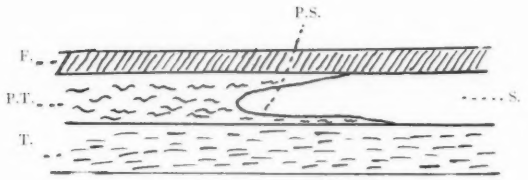


Fig. 16, I.

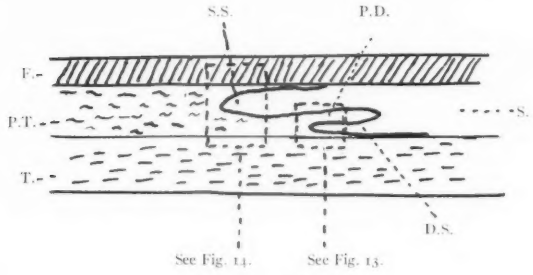


Fig. 16, II.

Fig. 16. Diagrams, explaining the difference between (I) the plica simplex and (II) the plica duplicata. *P.S.* Plica simplex; *S.* sheath; *F.* fascia; *P.T.* paratenon; *T.* tendon; *S.S.* superficial pocket of the sheath; *P.D.* plica duplicata; *D.S.* deep pocket of the sheath.

Both are prolongations of the paratenon into the sheath. The plica duplicata is doubled on itself so as to form a tongue-like projection; the plica simplex is a simple reflection. The dotted rectangles indicate the topography of microscopical sections Figs. 13 and 14.

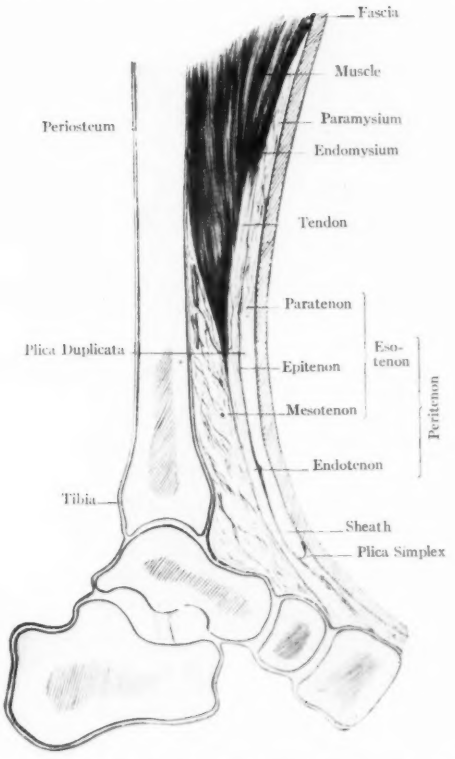


Fig. 17. Ideal longitudinal section through the tendon of the tibialis anticus tendon and the adjacent structures. See text for description.

pockets, a superficial and a deep. Macroscopically, the structure is easily demonstrated as a thin membrane enveloping the tendons of the tibialis anticus (see Figs. 11 and 12), extensor proprius hallucis and extensor longus digitorum. The tibialis posticus and flexor longus digitorum tendons may or may not show the fold, the flexor longus hallucis rarely does. The peroneal tendons are separated from one another in the upper part of their sheaths by an analogous structure. This fold was termed the plica semilunaris by Hartmann. Its shape is more that of a sickle, however, so the term plica falciformis would be more applicable. As the shape varies from tendon to tendon, it would be wiser to emphasize the constant characteristic of the reflection — the peculiar doubling over itself — by terming it the *plica duplicata*. This term also serves to contrast it with another type of plica, the plica simplex, in which no such duplicature is present.

Viewed microscopically, the plica duplicata consists of a very vascular, loose connective-tissue core coated by a layer continuous with the synovial lining of the sheath (Fig. 13). At the two points of reflection of the plica, the upper pole of the superficial and deep pockets of the sheaths, this layer is also synovial in character (Fig. 13 and 14). The synovial cells distally, however, do not form a continuous lining. Frequently, as in Fig. 15, they are not demonstrable and the surface of the plica is irregular in contour and consists of very fine connective-tissue fibers.

The second type of plica, the plica simplex, is a fold of connective tissue lined with synovial cells, forming the boundary of the

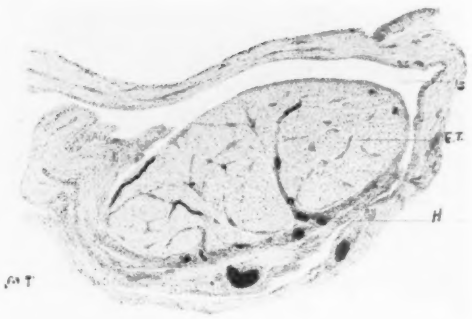


Fig. 18. Microscopical cross section through the tendon of the flexor longus hallucis (8 months infant). The vessels were injected, previous to fixation with a suspension of Turnbull's blue in glycerin. Leitz obj. 1, oc. 4, tube 150. *M.T.* Mesotenon; *S.* sheath; *E.T.* endotenon; *H.* hilus of the tendon with longitudinal vessels cut transversely.

The mesotenon lies in folds on the floor of the sheath. The longitudinal vessels of the mesotenon and of the hilus of the tendon are cut transversely. The smaller anastomostic vessels of the tendon, running transversely or in a slanting direction, are shown in longitudinal section.

upper and lower poles of many sheaths. It differs from the first type of plica only in the absence of a double fold (see Fig. 16). The connective tissue above the sheath is reflected downward over the tendon much

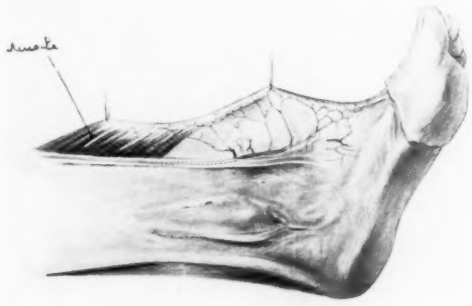


Fig. 19. The blood-vessels of the extensor proprius hallucis, injected with gelatin-cinnabar. The sheath has been opened and the tendon lifted out so as to put the mesotenon on the stretch. From the dorsalis pedis artery five branches run through the mesotenon to the hilus of the tendon, and form an extensive anastomosis in the epitenon. (The number of branches varies in different individuals, but the principle of the vascular system is constant.)

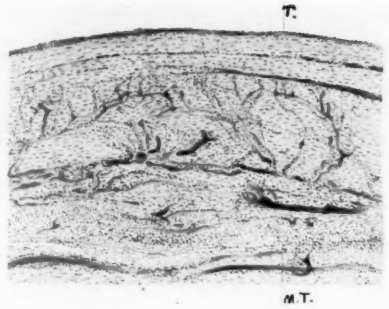


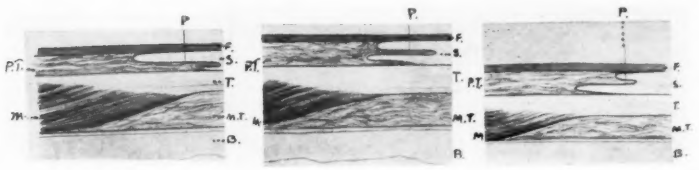
Fig. 20. Longitudinal microscopical section through the tendon of the extensor proprius hallucis (6 months infant). The vessels were injected previous to fixation with a suspension of Turnbull's blue in glycerin. The drawing shows the vessels in two successive serial sections, each 50 microns thick. Note the numerous vessels passing from the mesotenon (*M.T.*) into the tendon. Near the friction surface (*T*) of the tendon, however, no vessels are present.

as the conjunctiva is reflected from the lid to the eye bulb. This type of plica forms the usual distal boundary of the sheath.

These primary anatomical facts and the nomenclature which I have suggested in place

Fig. 21. The vascular system of the flexor longus hallucis tendon; the vessels injected with gelatin-cinnabar.

The sheath has been opened and the tendon lifted out so as to demonstrate the vessels running in the epitenon. The epitenon is situated on that surface of the tendon where friction against bone or ligament is least likely; that is, on the convexity of the tendon as it rounds the groove in the tibia, astragalus, and calcaneus. The vessels reach the tendon by two main branches: (1) a proximal, running either in the lowermost muscular fibers, as in this instance, in the proximal vinculum or in the mesotenon; (2) a distal, running in the distal vinculum triangulare. For the vascular supply of the tibialis posticus tendon see Fig. 5.



A. *B.* *C.*

Fig. 22. Three diagrams illustrating what takes place at the upper pole of the sheath of the tibialis anticus tendon during a contraction of the muscle. This invagination mechanism is found only in young muscular individuals. (See Fig. 24 for another type of gliding mechanism.) *P.T.* Paratenon; *M.* muscle; *P.* plica; *F.* fascia; *S.* sheath; *M.T.* mesotenon; *B.* bone.

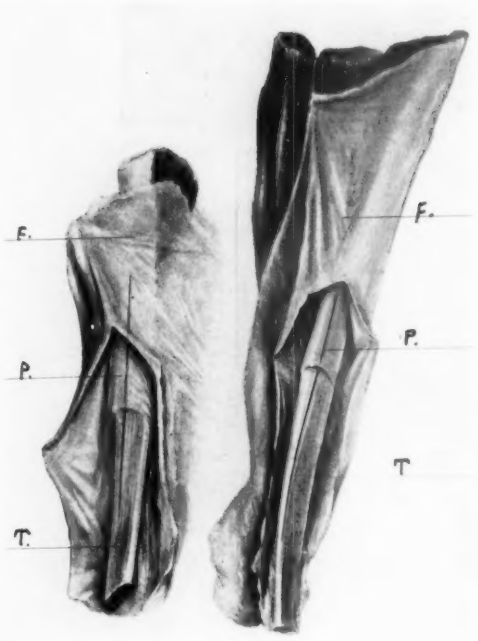
of the misleading older terminology can best be summarized by a diagram.

Figure 17 is an ideal longitudinal section through the tendon of the tibialis anticus and the adjacent structures. The *sheath* is interposed between fascia and tendon, where the tendon changes its direction. It does not, as usually maintained, give the tendon an increased range of motion, since the tendon glides as freely above the sheath as within it. Above and below the sheath, between the fascia and the tendon, is interposed the *paratenon*, a loose, vascular, fatty connective tissue rich in elastic fibers. The paratenon is prolonged downward into the sheath as a tongue-like fold, the *plica duplicata*, so termed to distinguish it from another type of reflection usually found at the lower pole of the sheath, the *plica simplex*. The *mesotenon*, continuous with the paratenon, connects the tendon with the floor of the sheath and transmits blood-vessels to the tendon. It expands on the surface of the tendon, forming a delicate, almost microscopical layer, the *epitenon*. Paratenon, epitenon, and mesotenon constitute the *esotenon* as opposed to the *endotenon*, the connective-tissue strands within the tendon (old terminology: peritenonium internum). For all the connective-tissue structures associated with the tendon the old term *peritenon* may be employed.

2. *The blood-vessels of the tendon.* Probably because Koellicker in his classical textbook stated that the tendons contain practically no blood-vessels, little attention has been paid to their vascular supply. I know of only two papers dealing with it, those of Wollenberg and of Arai. Wollenberg injected the femoral artery with an emulsion of mercury and turpentine and took roentgenograms of the tendons after these injections. Arai injected with India ink and made microscopical sections. Both papers, though of value, leave many important points unanswered. To gain a clear conception of the blood supply of tendons, one must combine macroscopical study and microscopical investigations of the tendon. For macroscopical study I injected the femoral artery (after preliminary washing out with saline solution) with a thin gelatin solution colored with cinnabar. This solution penetrated the capillaries and gave excellent pictures of the distribution of the vessels in the mesotenon. For microscopical purposes I found more satisfactory a suspension of Turnbull's blue in glycerine. Tendons thus injected can be fixed in formalin, imbedded in celloidin, cut, and stained in the usual way without affecting the brilliant blue of the dye.

The results of the investigations show that Koellicker's conception of the tendon as practically bloodless is incorrect. Though much less vascular than muscle or the surrounding loose connective tissue, the tendon contains numerous vessels, except near its friction surface. Here practically no blood-vessels are visible. In general the vessels of the tendon are derived from three main sources: (1) from muscular branches; (2) from vessels running in the surrounding connective-tissue paratenon, mesotenon, and the vincula; (3) from vessels of the bone and periosteum near the point of insertion of the tendon.

These vessels travel in the hilus of the tendon, in the epitenon, and in the connective-tissue septa between the tendon bundles (the endotenon) and anastomose freely by transverse and oblique branches. Figure 18, a transverse section through the flexor longus hallucis tendon, shows the longitudinal vessels



B. A.

Fig. 23. Two drawings of the tendon of the tibialis anticus: (A) During the phase of muscular relaxation, (the foot in equinus). (B) During the phase of muscular contraction (the foot in calcaneus). *F.* Fascia; *P.* plica; *T.* tendon free in sheath. In each instance the superficial pocket of the sheath has been opened up to the upper pole, a bristle has been passed into the deep pocket until it encounters the resistance of the reflection of the plica to the tendon (that is the upper pole of the deep pocket, (see Fig. 16).

In *A* the deep pocket is 1.0 cm. deep; in *B*, 2.8 cm.

This type of gliding mechanism is found frequently in young individuals and in most adults.

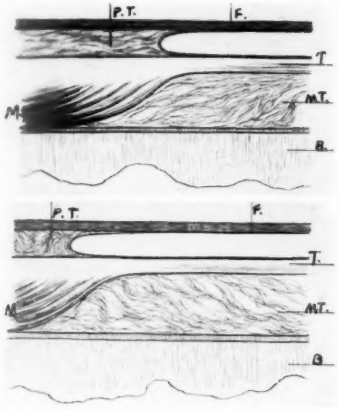


Fig. 24. Two diagrams illustrating the gliding mechanism of the plica simplex (tendon of the flexor longus hallucis); *a* (above) during the phase of muscular relaxation. *b* (below) during the phase of muscular contraction. *M.* Muscle; *P.T.* paratenon; *F.* fascia; *T.* tendon; *M.T.* mesotenon or vinculum; *B.* bone.

The motion of the tendon is allowed by the elasticity of the paratenon and mesotenon, whose fibers are stretched during muscular relaxation, that is, when the antagonistic muscles draw the foot into calcaneus; contracted, when the flexor hallucis draws the foot into equinus.

cut transversely and some of the transverse and oblique branches cut longitudinally.

The tendons are most vascular near the insertion of the mesotenon; that is, near the hilus. Here the numerous branches of the mesotenon (Fig. 19) ramify in the epitenon and send numerous fine twigs into the tendon (Fig. 20). Where the mesotenon is absent, the vessels reach the tendon through the vincula and usually give rise to a longitudinal vessel, which runs in the epitenon on the surface of the tendon protected from friction and sends out numerous transverse branches (Fig. 21).

An accurate knowledge, not merely of these general principles, but of the vascular system of each individual tendon is of practical value in tendon operations. The tendon of the flexor longus hallucis, for instance, derives its blood supply regularly from a vessel which, reaching the tendon via the proximal vinculum or the lowermost fibers of the muscle, runs downward on its posterior surface (see Fig. 21) and anastomoses with a corresponding vessel of the distal vinculum. In transplanting the tendon to replace a paralyzed Achilles tendon, the surgeon can, with a little care, avoid injuring this dorsal vessel and thus insure the viability of the tendon.

3. *The mechanism of the gliding of tendons.* Previous studies of tendons have been concerned almost entirely with their anatomy or their healing process after tenotomy. Despite thousands of tendon operations no one has yet attempted an analysis of certain physiological problems which are of peculiar significance in the technique of tendon operations. I refer particularly to the gliding mechanism of the tendon and to its normal

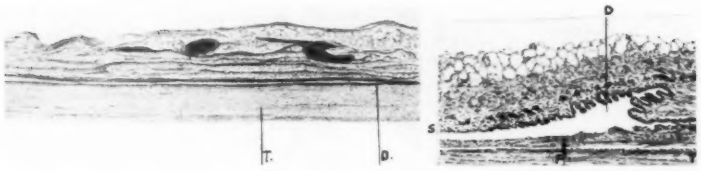


Fig. 25. Two microscopical longitudinal sections of the lower pole of the tibialis anticus sheath of a dog; *a*, (at left) during the phase of muscular relaxation (the foot in equinus) *b*, during the phase of muscular contraction (the foot in calcaneus). *b* is magnified more highly than *a* so as to show in detail what occurs when the muscle contracts. We are dealing here with a plica simplex. *T*. Tendon; *D*. distal pocket of the sheath; (in picture at right) distal reflection of the sheath: the plica simplex; *P*. plica drawn upward by the tendon; *S*. synovial layer of the sheath.

tension. The practical importance of these physiological facts is self-evident. If the operator wishes to prevent disastrous post-operative adhesions, he must first understand the normal gliding mechanism of the tendon. If he wishes to suture the tendon in such a way as to secure the maximum effect, he must know the laws of tendon tension.

On first thought the gliding of a tendon seems to present no question for investigation. Of course, one says, the tendon glides just exactly as two joint surfaces glide over each other; but just as the knowledge of joint motion requires a fine appreciation of many mechanical laws, so too the gliding of the tendon necessitates careful mechanical analysis. The problem is best understood by focusing on a specific example — the tendon of the tibialis anticus, for instance. We have already seen, in considering the anatomy of tendons, that the tendon sheath is interposed between the fascia and tendon to act as a buffer where the tendon changes its direction. The fascia forms the outer wall of the sheath, and, as the fascia above the malleoli is firmly fixed to fibula and tibia, the complete motion of the tendon, which in an adult ranges between 3 and 4 cm., must occur between the tendon and the wall of the sheath. Between this rigid wall and the bone, the tendon glides much as the piston of an engine glides to and fro within the cylinder. The essential difference, however, between the sheath and the cylinder is that the cylinder is not attached to the piston, whereas the sheath at its upper and lower poles is firmly attached to the tendon. Were cylinder and piston made fast to one another, gliding of the one within the other would be impossible. What, then, allows motion to occur in the case of the tendon? Evidently some mechanical con-

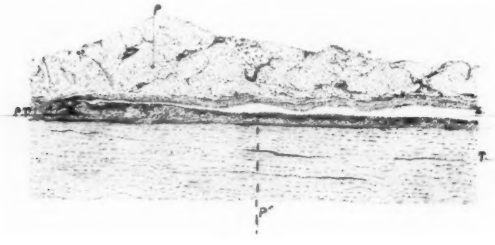


Fig. 26.

Fig. 27.

Fig. 26 and 27. Two microscopical longitudinal sections though the tendons of the flexor sublimis digitorum (adult). Leitz obj. 1, oc. 4, tube 140.

Fig. 26. Phase of muscular relaxation. *P.T.* Paratenon; *P*. fascia; *S*. sheath; *T*. tendon; *P.'* plica simplex (stretched).

Fig. 27. Phase of muscular contraction. Point "P" represents the same level of the palmar fascia. *P.T.* Paratenon; *P*. fascia; *S*. sheath; *T*. tendon; *P'*. plica simplex (contracted).

The motion of the tendon (4 cm.) has been allowed by the relaxation and contraction of the plica and paratenon.

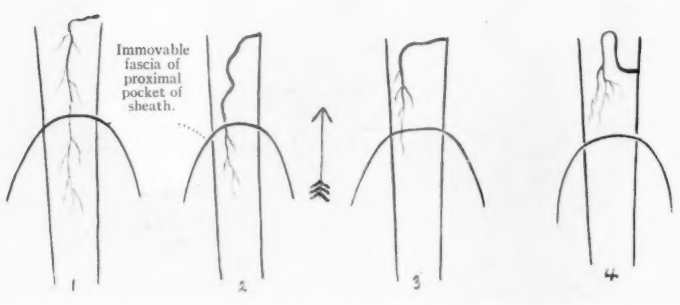


Fig. 28. Four sketches of a blood-vessel on the surface of the extensor carpi radialis longus during successive phases of muscular contraction. No. 1 represents the phase of maximal muscular relaxation; No. 4 of maximal contraction. The arrow indicates direction of tendon motion. The fascia of the proximal pocket of the sheath, represented by the bowed line remains almost immovable. The change in the course of the blood-vessel indicates the corresponding contraction of the fibers of the paratenon and plica.

trivance must be present by means of which the sheath, though closely united on the one hand to the immovable fascia and on the other to the freely gliding tendon, can, without tearing, accompany every motion of the tendon.

To study this problem three methods were open to me:

1. *Direct observation on the cadaver, controlled by microscopical sections.* The technique was the following: The joints, stiffened by rigor mortis, were mobilized by tenotomy of all the tendons except the one to be studied. Its muscle belly was then freed from its origin and braided for a considerable distance with stout cord, so that by traction on the cord the tendon could be made to move in much the same way as when the normal contraction of the muscle took place. Thus the relations of the tendon, the sheath, the fascia, the plica, the paratenon, and the mesotenon could be studied during all the phases of tendon motion from the extreme contraction of the muscle to its maximal relaxation. The macroscopical observations were in many instances controlled microscopically by sections of the sheath and tendon fixed during a definite phase of muscle contraction.

2. *By animal experimentation.* The amputated leg of a dog was faradized while the muscle-cells were still capable of responding to the electric current, and while thus contracted the limb was plunged into formalin and held there until the muscle-cells were fixed in the contracted state. Tendon and muscle were then imbedded in celloidin and microscopical sections prepared. By faradizing antagonistic muscles of the opposite leg, the corresponding tendon could be studied during the phase of muscle relaxation.

3. *Occasionally during operations on human beings*, it was possible to control the results of cadaver observations and animal experiments.

The results of these observations show that each tendon possesses a peculiar gliding mechanism, which varies slightly in each instance but is always dependent upon one basic principle: viz., the peculiar elasticity of the paratenon and the related plica and mesotenon. These facts are best understood by a series of diagrams and pictures.

Figure 22 shows three diagrammatic longitudinal sections through the tendon of the tibialis anticus at its entrance into the sheath. In *A* the muscle is relaxed; the foot is consequently in equinus. In *B* the muscle has partly contracted so that the foot forms an angle of 90° with the leg. In *C* the muscle has reached its maximum contraction. The tendon has moved exactly 2.5 cm. during the contraction. To permit this range of motion the plica duplicata has

invaginated itself. The fascial wall of the sheath has remained immobile; the upper end of the sheath, however, though attached to the fascia, has, by virtue of the elasticity of the plica, followed the motion of the tendon.

This invagination does not occur in all individuals. I found it usually in children and in young adults. In older individuals and in those whose muscles were not well developed, little invagination took place. The motion occurs chiefly by a deepening of the pocket between the plica and the tendon (see Fig. 23) or in a contraction of the paratenon with little or no change in the form of the plica.

When a plica simplex is present, as in the instance of the tendon of the flexor longus hallucis, the gliding mechanism is again dependent upon the elasticity of the paratenon. Reduced to the simplest form, the mechanism is represented by Fig. 24. For the details of the mechanism the animal experimentation was of value. Figure 25 shows the distal end of the tibialis anticus sheath of a dog; in one the muscle is relaxed, in the other the muscle is contracted. (For the technique, *vide supra.*) During the contraction of the muscle the tendon has drawn the plica with it inside the sheath and the synovial membrane of the sheath has accommodated itself to its new position by numerous folds.

In Figs. 26 and 27 are seen the tendons of the flexor sublimis digitorum of the third and fourth fingers, one when the finger is extended, the other when it is completely flexed. The elongation of the sheath by the contraction of the paratenon and the folding of the synovialis is clearly evident. Figure 28 gives four sketches of a blood-vessel on the surface of the tendon during successive phases of the contractions of the muscle. The change in the course of the blood-vessel illustrates the corresponding contraction of the fibers of the paratenon.

Above the sheath the gliding of the tendon beneath the comparatively rigid fascia is allowed by this peculiar elasticity of the paratenon. By incising the fascia and lifting the tendon out of its bed one can realize the degree of this elasticity; for the paratenon

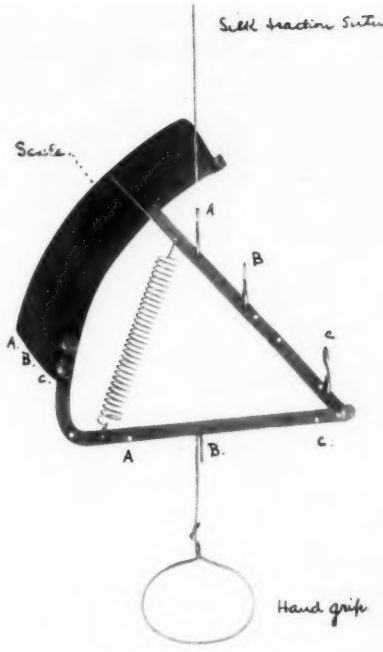


Fig. 29. The spiral spring scale used to determine the tension of the tendon. The three systems *A*, *B*, and *C* permit exact readings from 50 grams to 10 kilos by merely shifting the grip and the silk traction suture. System *A* gives the finer readings, system *C* the traction over 1 kilo.

can then be stretched to form a membrane 4 to 6 cm. wide.

When describing the mesotenon I called attention to the fact that its width diminishes as the tendon approaches its insertion: the mesotenon of the tibialis anticus or of the extensor proprius hallucis, for instance, is 3 to 5 cm. wide at the level of the malleoli, and only 1 or 2 cm. wide at the lower pole of the sheath. This anatomical fact illustrates the nicety of the gliding mechanism of the tendon; *the width of the mesotenon indicates the degree of motion occurring between the tendon and the bone.* Above the malleoli the total motion of the tendon must occur between the tendon and the bone, since the tibia remains fixed during the muscular contraction, whereas below the malleoli the relative motion of tendon against bone diminishes rapidly, since the foot moves

TABULAR SURVEY OF THE TENDON OF THE TIBIALIS ANTICUS

BASED ON MEASUREMENTS OF 20 ADULTS

LENGTH OF THE SHEATH

	During Phase of Maximal Muscular Relaxation	During Phase of Maximal Muscular Contraction
Above the intermalleolar line	4.0 to 5.7	5.0 to 7 cm.
Below the intermalleolar line	1.8 to 3.0	1.5 to 2.5

PLICÆ

Proximal = Plica duplicata

	During Phase of Maximal Muscular Relaxation	During Phase of Maximal Muscular Contraction
Length of the superficial pocket	1.3 to 3.3 Average 1.7	0.3 to 2.3 Average 1.0
Length of the deep pocket	0.2 to 2.2 Average 0.8	1.2 to 4.5 Average 2.7

Distal = Plica simplex

MESOTENON

Present in 100 per cent; inserts into the posterior lateral aspect of the tendon. Maximal width at the level of the malleolæ 3.5 to 4.0.

BURSÆ

1. Between the tendon and the internal cuneiform, near the insertion of the tendon. Lessens friction during supination.

RANGE OF TENDON MOTION

Adult 3.5

Children 1.5–2.5 (8 cases)

VASCULAR SYSTEM

Vessels derived

1. From muscular branches
2. From vessels of periosteum and bone at insertion of the tendon.
3. 3 to 5 branches of the dorsalis pedis running in the mesotenon.

Form extensive anastomosis in the epitenon in the posterolateral aspect of tendon.

with the tendon when the extensor muscles contract.

The practical significance of these facts is evident. If the tendons are thus normally equipped with a delicate gliding mechanism, the operator must respect its niceties. In many instances of tendon transplantations it is possible to retain this gliding apparatus intact; in other instances where the normal mechanism must be interfered with, the operator should try to restore the normal conditions.

4. *The tension of the tendon.* The tension of a tendon is of as great practical significance as the mechanism of its motion. By a happy coincidence Dr. Stoffel of Mannheim has been investigating this question of tendon tension, and his results, based upon quite a different mode of study, are in full accord with mine. My experiments were performed chiefly on dogs. A few control observations were also made in the course of operations on human beings. The exact question which I wished to determine was: What is the tension of a tendon when the muscle is at rest and the individual under deep narcosis? This is the all-important practical question, for the operator who wishes to perform a tendon plastic physiologically, must suture the transplanted tendon under this tension.

The technique of the experiments was the following: The tendon, usually the tibialis anticus or the Achilles tendon was laid bare 2 cm. above its point of insertion. The tendon was securely braided by an overlapping stitch in such a way as to allow traction of at least 20 pounds upon the silk suture without tearing it out of the tendon. The tendon was then divided just distal to the silk strands and a delicate spiral scale (Fig. 29) attached to the silk, by means of which the tension of the tendon could be accurately measured. All one had to do was to pull on the handle of the scale until the two divided ends of the tendon were brought into contact. The results of these measurements showed: First, that when the origin and the insertion of a muscle and its tendon were approximated, the tendon under the condition of the experiment (deep narcosis) was entirely without tension. The delicate spiral scale showed exactly at zero. Second, that when origin and insertion were separated to the physiological limit it required a traction of 300 to 500 grams to unite the tendon ends; in other words, the tendon is under tension. In the case of the Achilles tendon two other peculiar facts could be demonstrated. When the dog's knee was flexed and at the same time the foot was brought into a position of equinus, the tendon ends actually overlapped, i.e., the tendon was under negative tension. Conversely, when the knee was extended and

the foot brought into the position of calcaneus, it was absolutely impossible, even with a traction of 30 pounds to bring the tendon stumps together; muscle and tendon evidently were being taxed beyond their normal physiological limit. Ludwig Fick, in his *Anatomie der Gelenke*, has also called attention to this peculiarity of muscles which run over two joints and has labelled such muscles actively or passively insufficient.

Muscle and tendon have a definite length, happily termed by Stoffel their physiological length. This length can vary within the range of the normal motion of the joints bridged by the muscle and tendon. If an abnormal position of the joints is assumed as, for instance, in the case of the dog, flexion of the knee and extension of the foot, tendon and muscle are unable to accomodate themselves to this unusual demand.

When a muscle is faradized, the tension of the tendon varies directly with the strength of the current and the strength of the muscle. In dogs weighing 15 to 20 pounds, the tension of the tendon during contraction of the muscle ranged from 800 to 10,000 grams. Also in those experiments where the muscle was allowed to contract voluntarily as the animal awoke out of the anæsthesia similar readings were made.

The practical application of these laws is simple. To restore the normal tension the operator need only approximate origin and insertion of the muscle and tendon in question and suture the tendon to its new position without any tension whatsoever. For instance, in transplanting the peroneal tendon for the paralyzed tibialis anticus, the foot should be held in the position of calcaneovarus and the peroneal tendon sutured to its new point of insertion with just sufficient tension to render it taut.

II. The Anatomy and Physiology of the Individual Tendons

I have now outlined the general facts of tendon anatomy and physiology. The conscientious surgeon, who wishes to perform tendon operations with the maximal benefit to his patients should be acquainted not merely with these general facts but with the exact anatomy of each individual tendon. In these papers it is impossible to condense this mass of details: the surgeon is referred to the monograph *Die physiologische Sehnenverplanzung*[1] by Biesalski and Mayer. I append a tabular survery of the tendon of the tibialis anticus to indicate the nature of the anatomical study of the individual tendons.

Summary

In this, the first of three papers dealing with the physiological method of tendon transplantation, I have outlined the inception of the research and the basic facts of tendon anatomy and physiology. The research is the logical outgrowth of an extensive series of animal experiments conducted during 1912 in the clinic of Professor Lange, Munich, in which the principle of Biesalski's tendon operation—the restoration of the normal relationship between tendon and sheath—was given ample experimental verification. The natural sequence was the perfection of the technique of Biesalski's operation so as to render it physiologically correct in all its various phases.

To do this the hitherto vague or unknown finer anatomy and physiology of tendons had to be investigated by anatomical dissection, controlled by microscopical preparations by animal experiments and by observations at the operating table. Thus equipped with more accurate, though still far from complete knowledge of the physiology of tendons, it has been possible to formulate an operative technique in which these facts are the fundament.

In the second paper I shall describe in detail three typical physiological tendon transplantations; in the third, I shall report the experimental and clinical results of the physiological method.

[1] Published by Springer, Berlin.

FRACTURE OF THE VERTEBRÆ WITHOUT CORD SYMPTOMS

PERCY WILLARD ROBERTS, M.D., NEW YORK
Associate Attending Orthopedist, Mt. Sinai Hospital; Assistant Orthopedic Surgeon, Hospital for Ruptured and Crippled, and Post-Graduate Hospital

FRACTURE of the vertebræ without cord symptoms of sufficient severity to attract attention is a condition frequently allowed to go unrecognized, yet it is not uncommon. In the past year four cases of this nature have come under the writer's observation and in all but one the patients were discharged from hospitals with the assurance that they were physically sound. It goes almost without saying that fracture of a vertebral body is fraught with serious possibilities if not properly treated. Even though the immediate results of such an injury are apparently trifling, the broken bone may undergo a process of rarefaction and attrition with the appearance, some months later, of cord symptoms, increase of deformity, pain, and weakness. The importance, therefore, of careful examination of all spine injuries is obvious. It is possible that failure to recognize lesions of this type is due to the very prevalent idea that fractures of the vertebræ are always accompanied by evidence of cord pressure. Such is the impression to be gained from most textbooks on the subject which specifically state, to quote from one well known author, that in fracture of the spine "paralysis is the most important and constant symptom," while nothing is said of the possibility of fracture without this condition. Thus occurs the belief among those whose practice is not chiefly concerned with bone and joint work that the absence of paralysis in one form or another is a reasonable basis for excluding vertebral fracture. It is true, nevertheless, as Case 2 well illustrates, that there may be fracture of more than one vertebra with displacement of fragments without interference with locomotion or vesical or rectal control. In traumatism of the spine the

Fig. 1. Case 1. Fracture of first lumbar vertebra showing typical posture.

Fig. 2. Case 1. Fracture of first lumbar vertebra with displacement of fragment.

Fig. 3. Case 2. Fracture of sixth and seventh dorsal vertebræ with rounded deformity of spine.

presence of paralysis is suggestive of fracture, yet it is not conclusive, inasmuch as cord pressure from hæmorrhage may produce a loss of muscular power. Of greater importance in determining the probability of fracture is examination of the spine for a point of localized tenderness. If this is found and is accompanied by deformity, such as a sharp knuckle or a rounded curve, which is the more frequent abnormality, fracture may be assumed. The findings will be confirmed or disproved by radiographs provided they are well taken. For this purpose apparatus of high penetration is often necessary. It is not sufficient to depend upon an X-ray plant which may be efficient for ordinary work, especially if the injury involves one of the upper seven dorsal vertebræ. In this situation the scapulæ are interposed between the plate and the tube and offer sufficient resistance to the X-rays to yield indistinct shadows unless the penetration is unusually high. This point is well illustrated in Case 2 in which two sets

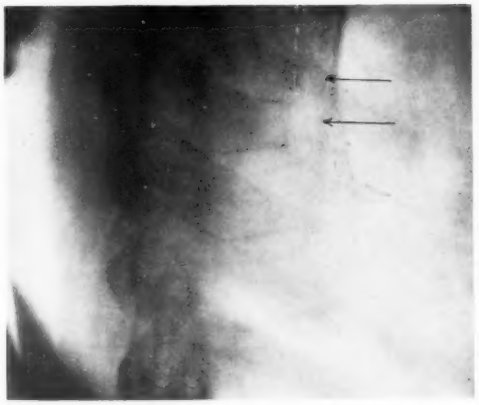


Fig. 4. Case 2. Lateral view showing crushing of two vertebræ.

of plates, taken with an apparatus of ample power for ordinary bone work, failed to reveal the fractures which were afterward clearly demonstrated by a plate taken by the same radiographer, using a machine of higher penetration.

While it may be that many cases of compression fracture of the vertebral bodies eventually recover without special treatment, it is unsafe to assume that all will do so. Case 3, for instance, had no cord symptoms until ten months after injury, when weakness of legs developed, followed by paraplegia which, it may be assumed, was due to absorption of the crushed spongy tissue permitting further collapse of the unsupported spine, with consequent pressure on the cord. Cases 1 and 2, while having no paralysis, complained of their inability to resume hard work because, on lifting heavy weights, their backs seemed weak and were somewhat painful. Both recovered by the aid of a properly fitting brace. Where external mechanical support fails after a reasonable period the insertion of a bone graft to include two spines above and two spines below the injury would seem to be indicated, but in none of the cases of this series was such procedure considered necessary.

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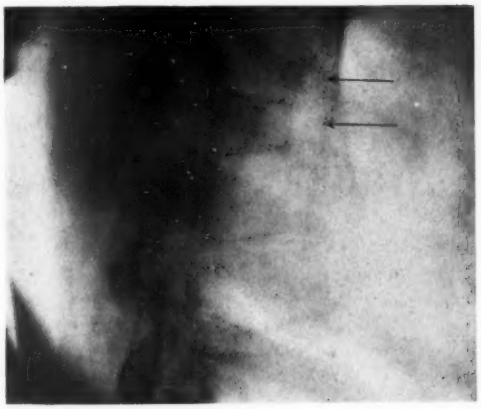

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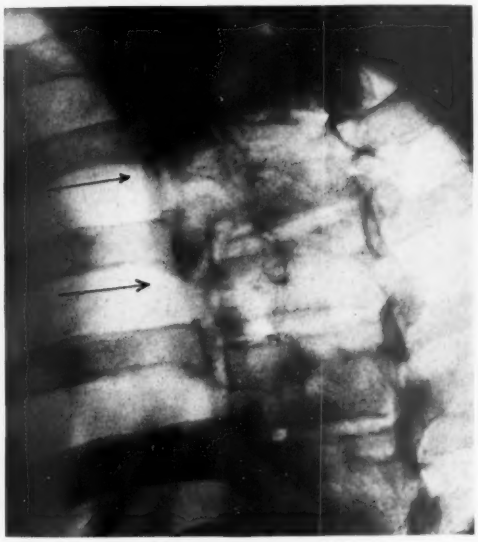

Fig. 5. Case 2. Anteraposterior view showing crushing of two vertebræ.

Fig. 6. Case 3. Lateral view showing severe crushing of vertebral body and displacement of fragment.

curve, differing somewhat n its appearance from the kyphos of Pott's disease which in acute cases partakes of shorter and sharper lines (Figs. 1, 4, and 8.).

Of subjective symptoms one case complained of occasional dizziness which disappeared entirely when external support was applied, and the others only of pain on bending the spine, and weakness.

Case 1. M. J. C., age 40. Fell a distance of fifteen feet striking his back. Was assisted to his home and remained in bed two weeks. Had no loss of power in legs and no bladder or rectal symptoms. Was then allowed up, apparently well, but in attempting to resume his work as a carpenter, found he was unable to do any lifting. Ten weeks later he was referred to the writer for advice. Up to this time no diagnosis of fracture had been made. There was present in the dorsolumbar region a rounded deformity (Fig. 1) and a point of distinct tenderness over the first lumbar vertebra. Fracture was suspected and a radiograph showed the first lumbar vertebra crushed into a wedge-shaped mass (Fig. 2). A Taylor spinal brace was applied, to be worn night and day, four weeks rest enjoined, and the man has since been at work without symptoms.

Case 2. E. W., age 32. Fell from a tall cherry tree. Position on landing not known. Was unconscious when picked up and did not regain consciousness for an hour and a half. Complained of pain in shoulder and at a point corresponding to the sixth dorsal vertebra. Right clavicle fractured. No paralysis of legs; no interference with bowels or bladder. Was taken to a hospital where he remained in bed eight days; treated for contusion; discharged as recovered. His family at once noticed decided round shoulders (Fig. 3), which he did not have before the accident, and patient complained of pain between the scapulæ, with occasional attacks of dizziness. Eight weeks later he appeared at the Hospital for Ruptured and Crippled for advice as to his round shoulders and pain. There was a point of tenderness over the sixth dorsal vertebral spine. Two sets of radiographs failed to reveal any bone lesion, but a third, taken by Dr. B. C. Darling with an apparatus of high penetrating power, showed fracture of the bodies of the fifth and sixth dorsal vertebræ with displacement of fragments (Figs. 4 and 5). A spinal support was applied to be worn day and night. The occasional dizziness disappeared, and the man has since had no symptoms.

Case 3. P. O. D., male, age 35. Fell October 27, 1913, a distance of fifteen feet from a scaffolding and a beam fell across his left shoulder, fracturing the clavicle and dislocating the shoulder. He was in a hospital for several weeks where the clavicle and shoulder were treated, but nothing was done for the spine. He had no paralysis and, when seen at the Hospital for Ruptured and Crippled seven months later, walked well but complained of tiring easily. He said he had never had any trouble with bladder or bowels. He had a rounded deformity in

Fig. 7. Case 4. Fracture of tenth dorsal vertebra showing rounded deformity of spine.

Fig. 8. Case 4. Lateral view of spine showing crushing of tenth dorsal vertebra.

the lower dorsal region and a point of tenderness over the tenth dorsal vertebra. A radiograph showed severe crushing of this bone and displacement of the anterior fragment (Fig. 6). A spinal brace was applied, but the patient would not wear it at night. Two months later his wife reported that he was unable to walk. As he lived at a distance from New York he was advised to seek surgical aid in his own city.

CASE 4. F. W., female, age 16. Fell off the steps leading to her house and was taken to Bellevue Hospital for treatment. She was X-rayed, but no fracture discovered. Discharged after two weeks as recovered. Three weeks later sought advice for deformity of spine. There was a marked rounded kyphos in the mid-dorsal region (Fig. 7), with a tender point at its apex over the tenth dorsal vertebra. Diagnosis of fracture was made which was confirmed by a radiograph (Fig. 8). She said she had never had any paralysis and complained at the time only of a sense of general weakness and of tiring easily. Spinal brace was applied to be worn day and night. All feeling of weakness has disappeared and patient is without symptoms.

RENAL DYSTOPIA

With a Report of Two Cases

By THOMAS N. HEPBURN, A.M., M.D., F.A.C.S., Hartford, Connecticut

In January, 1913, Dr. S. C. Plummer of Chicago published in Surgery, Gynecology and Obstetrics an article on "Dystopic Kidney" in which he reviewed the literature to date of the clinical cases reported. This included 67 cases collected by Straeter, to which he added 17 cases, making a total of 84 clinical cases reported. Of these 84 cases, 63 were operated upon, and some renal surgery was done in 48 cases.

In 34 cases, nephrectomy was done: 23 recovered; 7 died; 4, no report of result.

In 3 cases, nephrotomy or pyelotomy was done: 1 recovered; 2 died.

In 3 cases, calculi were removed; recovered.

In 3 cases, the kidney's position was changed by reimplantation: all recovered.

In 3 cases, part of the kidney was excised: 2 died; 1 not reported.

In 1 case, the kidney was fixed to the abdominal wall; result not stated.

In 1 case, nephrectomy was attempted, but the patient died.

A most instructive fact brought out in Plummer's paper was the large proportion of nephrectomies done, 34 of them.

In 14 of these cases, the kidney was either hydronephrotic or pyonephrotic: 13 recovered; 1 died.

In 13 of these cases, the kidney was physiologically normal: 10 recovered; 3 died.

In 3 cases, the only kidney was removed and all died.

In 4 cases, the condition and result are not stated.

From the above statistics, it seems advisable to draw the following conclusions in regard to dystopic kidneys:

1. Do careful diagnostic work before operating so as to assure yourself that there are two kidneys present, and determine the functional capacity of each.

2. Unless the dystopic kidney is functionally impaired by disease, except in pelvic

Fig. 1. X-ray of sigmoid, Case 2, showing large shadow.

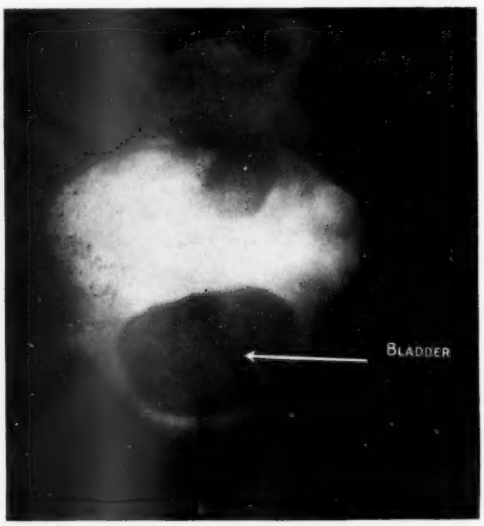

Fig. 2. X-ray, Case 2. No connection shown between two shadows.

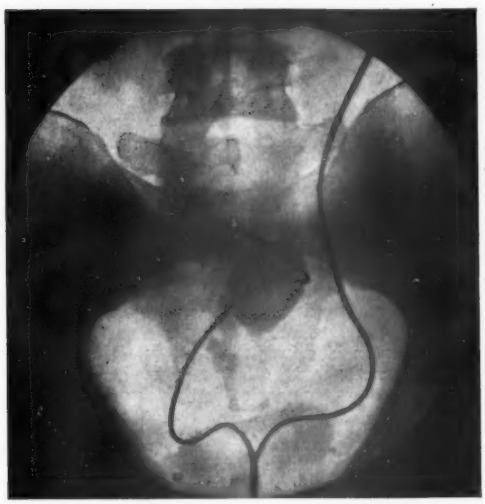

Fig. 3. X-ray, Case 2, showing catheters *in situ*, right catheter against stone shadow.

kidneys of women who are likely to become pregnant, nephrectomy should not be done.

To the above series of cases, I wish to add two.

CASE 1. Mrs. A. K., age 25; mill worker; German; referred by Dr. O. C. Smith. *History* was negative except for the present illness which was a complaint of pain in left pelvis for past 5 years. At times had had dysuria of mild degree. The non-catheterized urine showed a few pus-cells. The temperature was normal. A vaginal examination showed a mass in left pelvis taken to be a fibroid of the uterus. In order to insert guiding catheters for a contemplated hysterectomy, I cystoscoped her. This revealed:

The *bladder wall* slightly congested.

Right ureteral os normal, admitting a No. 7 catheter easily 25 cm., and clear urine flowed rapidly. A specimen of this urine was reported normal by the laboratory. *Left ureteral os* appeared normal but would admit a catheter only 4 cm. *Six gm.* of phenolsulphonephthalein was injected intravenously. It was excreted by the right kidney in 4 minutes and in 30 minutes, 38 per cent. None found from the left catheter or in the bladder.

A *diagnosis* was made of left ureteral obstruction (probably due to pressure of a pelvic tumor) and degeneration of left kidney with functional compensation of right kidney. Exploration of the pelvis was advised.

Operation, January 27, 1914, by Drs. O. C. Smith and Hepburn. Through a median suprapubic incision, the uterus was found normal. In the left pelvis was a cystic mass, very adherent to the surrounding structures. As we peeled it out, it appeared to be either in or under the broad ligament. When removed, it proved to be full of turbid fluid, and it was turned over to Dr. Henry C. Russ for pathological examination. Appreciating now for the first time that it might be a dystopic kidney, the left kidney was searched for but not found. The wound was closed and the patient made a complete recovery. Dr. Russ reported on the specimen as follows:

Cystic mass removed from the region of the left broad ligament. The external surface is smooth except for fibrous adhesions, and is of a purplish, somewhat mottled, appearance. The mass is nearly spherical, and about 10 cm. in diameter. The wall is thin and membranous except near the site of attachment, where there is a small amount of firm, nodular, gray tissue. In this tissue is part of a tube, ending blindly in the cyst wall, and cut across distally. It is about 3 mm. in diameter and lined by mucous membrane. The internal surface of the cyst shows numerous trabeculations. The lining is shiny.

The cyst content is yellow in color and clear, and has a slightly urinous odor. It is alkaline to litmus and does not respond to tests for urea. It contains a very large amount of albumin and microscopically there are a few flattened epithelial cells and blood-corpuscles.

Histologic examination. Sections show fibrous tissue infiltrated with lymphocytes and polymorphonuclear leucocytes. Distinct kidney parenchyma does not appear, though in many places are fairly definite, isolated tubules and in others are found sclerotic tufts containing capillaries and surrounded by an endothelial capsule, very much like degenerated glomeruli.

The inflammatory process is distinctly granulomatous in type; frequent nodules being found whose centers are fibrous while concentrically around are epitheliod cells and numerous lymphocytes and polymorphonuclear leucocytes. In some of these nodules, structures very similar to giant cells, are found.

Diagnosis. Chronic nephritis with marked hydronephrosis—miliary tubercles.

CASE 2. On November 18, 1914, Mr. E. C. B. of Meriden, Connecticut, was referred by Dr. O. C. Smith for diagnosis. He was 53 years old, married, a collector, an American. *Complaint:* Indefinite pain in left lower abdomen, suspected to be some trouble with sigmoid. His family history is unimportant. His past history is negative except that he has had this pain to some degree for over 30 years and that he thinks he passed two stones from his left kidney 8 years ago. General examination shows a rugged, healthy looking man, with nothing pathological to be seen or felt locally.

An X-ray of the sigmoid was taken and a large shadow was revealed, as shown in picture (Fig. 1). Some thought this to be in the bladder but a cystoscopy showed the bladder clear. To exclude the

possibility of its being a large calculus in a bladder diverticulum, the opening of which was so small I had overlooked it, I filled the bladder with 40 per cent argyrol and X-rayed again. The picture (Fig. 2) showed no connection between the two shadows and I was able to rule out diverticulum. I then became suspicious of a dystopic kidney and sent him into the Hartford Hospital so that I could give him a complete renal examination: cystoscopy, double ureteral catheterization, quantitative differential renal function, and X-ray with catheters *in situ*. The bladder was normal. The right ureteral os was normal. It admitted a No. 7 catheter 13 cm., and clear urine flowed well. A sterile specimen sent to the laboratory is reported to contain leucocytes and red blood-cells, but there is no growth on culture media.

The left ureteral os was normal. It admitted a No. 7 catheter 25 cm. and clear urine flowed well. A sterile specimen sent to the laboratory is reported normal.

Six milligrams of phenolsulphonephthalein was injected into the arm vein.

The left kidney excreted it in 4 minutes and in 30 minutes, 30 per cent. The right kidney excreted it in 5 minutes and in 30 minutes, 30 per cent. The patient was then X-rayed with the catheters *in situ* and the right catheter was found to be against the stone shadow (see Fig. 3).

A definite diagnosis was then made of a calculus in a right dystopic kidney of normal function, a normal left kidney being present.

Operation, December 8, 1914. Drs. O. C. Smith, Bell, Hepburn, and E. O. Smith of Meriden. A midline suprapubic incision was made. The peritoneum was peeled off from bladder. The stone was at once felt in the pelvis of a normal sized kidney, the cortex of which lay against the right brim of the small skeletal pelvis and two-thirds below it. While freeing the stone, which was 5 cm. in diameter, and therefore required a large opening in the renal pelvis, a renal vein, apparently coming off the right common iliac, was ruptured and this hæmorrhage required packing, so that no further investigation of the blood supply for scientific purposes seemed justified. Because of the normal function of the kidney nephrectomy did not seem advisable. A cigarette drain was put down to the renal pelvis and the bleeding-vein area was packed with gauze, which entirely controlled the hæmorrhage. The patient made a most satisfactory recovery with cessation of all painful symptoms.

ENORMOUS ABDOMINAL CYST, PROBABLY DUE TO A RETAINED TESTIS

By JOHN H. OUTLAND, M.D., Kansas City, Missouri
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AND
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IN one of the most delightful papers he has written since his residence in England Sir William Osler[1] calls attention to the diagnosis of abdominal tumors in the male, and states that no such diagnosis is complete unless an examination of the testis has been made. It might be added that the most important thing to find about the testes in such cases is that one or the other is not there.

Osler's three cases were of sarcoma due to a retained abdominal testis.

Bulkley[2] reports two cases of a similar nature and abstracts the histories of 57 other cases from the literature. He makes a very interesting and complete review of the litera-

[1] Lancet, Lond., 1907, i, 1409.
[2] Surg., Gynec. & Obst. xvii, No. 6.

Fig. 1. View of patient showing location of the tumor.

Fig. 2. The tumor removed at autopsy; kidney at left, spleen at right.

ture on the general subject of malignant disease of the testicle retained in the abdominal cavity, so that we do not intend to go into this matter here.

No mention is made in either Bulkley's or Osler's articles of a case similar to the one which we desire to report here; in no case was so large a tumor discovered, in none a cystic tumor at all approaching this one in size.

Case 1. This tumor had been noticed by the patient, a man of 65, for 15 years. It had grown very rapidly, however, for the last three years before it was operated on October 14, 1913. The patient's family history was negative. His personal history was of little moment save for the fact that he had never had but one testis in his scrotum, there being no trace of a testis in either inguinal canal. The tumor caused him great distress and dyspnœa, but no acute pain. He thought that it had sometimes receded in size and then slowly come up again.

He was an emaciated man with an enormous abdomen. His arteries were sclerotic.

The tumor extended from the lower edge of the left costal arch nearly to the crest of the pubes filling the entire side of the abdomen and extending nearly a hand's breadth to the right of the umbilicus. It fluctuated. It was not movable. There was no tympany over it. (It may be remarked here that the transverse colon was found, at autopsy, lying squarely across the tumor showing the lack of value of this old clinical sign in large tumors.)

The hæmoglobin was 84 per cent; reds 4,500,000; whites 6,000.

Laparotomy was done October 14, 1913, the incision being made at the left border of the left rectus. An enormous cystic tumor covered with a network of large veins was exposed. The splenic flexure of the transverse colon was over it and attached to it. A trocar removed two gallons (by measurement) of brownish opaque fluid the color and consistency of coffee after cream has been added to it. There were many globules of fat floating in it. After it was removed, the opening was widened and masses of cheesy material evacuated (perhaps cholesterin, perhaps organized fibrin). Any attempt to remove it would have been impossible. The walls of the cyst were sutured to the abdominal parietes.

The patient died in shock six hours after operation.

A partial autopsy was permitted and the findings, condensed and abridged, were:

In endeavoring to remove the cyst it was found to have dense attachments to the left dome of the diaphragm, to the side of the parietal wall, to the spleen, to the left kidney, to the vertebra and to the splenic flexure. The left kidney was spread out over it at one point and had two small cysts in the parenchyma. The ureter was densely imbedded in the wall of the cyst.

The tail of the pancreas was discreet and not involved in the tumor. The spleen was attached to it, forming the wall of the cyst at one point.

There was only one testis in the scrotum. No other testis was found in the inguinal canal or in the abdomen on either side after careful search.

The tumor after its removal was stuffed with cotton to take the place of the fluid removed from it and measured twenty-two inches long, eighteen inches wide, and thirteen inches high.

Sections taken from it at many places failed to reveal any testicular tissue, or any evidences of malignant cells. They merely showed the fibrous connective tissue of the wall of the cyst.

CARBOHYDRATE TOLERANCE IN HYPERTHYROIDISM [1]

By J. CHRISTOPHER O'DAY, M.D., Portland, Oregon

ON June 16, 1913, a patient came to me for examination and relief. His history follows:

Charles K., age 29, unmarried, carpenter; family history negative. Up to one year before consultation he had always been well. The first symptom he noticed was the appearance of a goiter, and upon consulting a physician he was advised to paint his throat with iodine. As the goiter continued to enlarge, he consulted a second medical man who placed him on the internal use of thyroid extract.

"In a short time," he said, "I was nervous and shaky and went to doctor number three." From his description, it would seem that he was this time treated by the high-frequency current, which cured his nervousness but did not reduce the size of the goiter.

In the early part of May, 1913, five or six weeks before his coming to me, he suffered a severe dermatitis of the face, neck, arms, hands, and the greater portion of the body from rhus toxicodendron. The effect of the "poison oak" endured about two weeks, and when it was well subsided he began to feel very nervous and to lose in weight. In short, he enumerated the classical symptoms of two diseases; namely, diabetes mellitus and exophthalmic goiter. That the two diseases were in any way dependent upon each other, did not occur to me at the time. I merely regarded their presence as a coincidence.

At about this time, Franklin C. McLean was working out the clinical significance of the sugar content of the blood in diabetes,[2] and the patient was requested to present himself at the McLean clinic to the end that he receive detailed attention.

A total restriction of the carbohydrates was unavailing in securing sugar-free urine, and while the percentage was markedly reduced, the sugar content of the blood remained unchanged. Later he developed a cough, and examination of the sputum made in the McLean laboratory revealed the bacilli of tuberculosis. December 19, 1913, the patient lapsed into coma and died.

My reason for referring to this case now is twofold: (1) At the time I did not know that hyperthyroidism was an etiological factor in diabetes. (2) The citation of the case may serve as a control while considering the following two similar cases.

On August 22, 1914, Carl C.,[3] age 24, came to us, presenting the same syndrome as in the above case. It being my opinion that he, too, would die within a few months, I so informed his parents. They had already received this opinion and were not surprised.

Having acquired some experience in the treatment of toxic goiter with the boiling water injection method of Porter, I applied it in this goiter jointly with the usual dietary treatment common to diabetes. He was admitted to the Good Samaritan Hospital the same day. Table I will show the rapid regaining of his carbohydrate tolerance, due, we believe, to the "cooking" of his thyroid gland.

TABLE I

Date	Urine		Injections of boiling water in minims	Diet
	Specific Gravity	Sugar		
Aug. 23	1,036	Yes	60	No carbohydrates.
Aug. 24	1,036	Yes	30	No carbohydrates.
Aug. 25	1,024	Yes	60	No carbohydrates.
Aug. 26	1,030	Yes	60	No carbohydrates.
Aug. 27	1,020	No	60	One slice white bread.
Aug. 28	1,022	No	60	One slice white bread.
Aug. 29	1,020	No	30	One slice white bread.
Aug. 30	1,018	No	30	One slice white bread.
Aug. 31	1,026	No	00	One slice white bread with each meal.

At the beginning of the boiling water destruction of his thyroid, the pulse ranged between 120 and 130 per minute. By the end of the month it was between 90 and 100. During the week following, as no change had taken place in his condition, we felt safe in attempting extirpation of the gland, and under the pretense of making the last, but largest injection of the boiling water, he was induced to take an anæsthetic, after which the operation was performed after the coffer-damming method of O'Day.

His recovery was surprisingly rapid, and within a comparatively short time his ingestion was totally unrestricted. Sugar was finally added in way of candies as a test, but his tolerance remained normal, determined by repeated examinations of the urine.

The very next month, October, 1914, my attention was called to an article in *The Monthly Cyclopedia and Medical Bulletin*, by Paul Sainton, M.D., and Paul Gastaud, M.D., of Paris, France. I will here acknowledge my indebtedness to these two gentlemen for the knowledge I gained from their splendid article, "Exophthalmic Goiter and Diabetes." They reported having met with three instances of diabetes among ninety cases of

[2] J. Am. M. Ass., lxii, 917.

[3] For detailed report of this case see N. Y. M. J., April 3, 1915.

[1] Read before the Oregon State Medical Society, September 10, 1915.

exophthalmic goiter, and after an extensive search of the literature found a total of sixty presenting this combination of conditions. Their findings show the frequency of diabetes in exophthalmic goiter as three in one hundred cases.

"Clinically," they go on to say, "diabetes occurring in the course of Graves' disease is manifest in two ways: (1) as a temporary or slight glycosuria with the usual symptoms of diabetes only present in a trifling degree; (2) as a well-established condition, with all the characteristic symptoms present, the latter frequently even dominating the clinical picture as a whole, mentioning a case reported by F. Muller, where the patient died in coma."

After summarizing the facts collected, reaching the conclusion that hyperthyroidism participates in the production of diabetes, they then admit that other factors should be considered, for they say: "Other glandular theories may, however, be put forth and these must be passed in review. Among them is the adrenal theory. Cases in point are uncommon, and the authors know of but one instance in which a patient afflicted with both exophthalmic goiter and Addison's disease showed temporary glycosuria (personal case). Discussion of the possibility of participation of the adrenals in such a glycosuria is rendered necessary by the fact that the Vienna school (Eppinger, Falta, and Rudinger; Eppinger and Hess; Krauss and Friedenthal; Asher) maintains the thyreo-adrenal origin of exophthalmic goiter. This theory is based on the relations supposed to exist between the thyroid, pancreas, and chromaffin system. In hyperthyroidism there would occur inhibition of the pancreas and stimulation of the adrenal function. The theory offers a plausible explanation of the clinical association in question, it being merely necessary to conceive that by reason of the pancreatic and thyreo-adrenal antagonism, the disturbance of pancreatic function might extend to complete suppression of glycogenesis.

"This theory is widely discussed. It has not been proved, indeed, that an increase of adrenal secretion takes place in Basedow's disease; epinephrin is not constantly present in such cases; finally, the association of hyperthyroidism with Addison's disease is hardly in favor of this conception. Basedow cases, moreover, do not show any constant change in the blood-pressure. True, Asher has noticed that in certain subjects with thyrotoxicosis the injection of ¼ to ½ mg. of epinephrin leads to glycosuria. Further investigation is required, however, to confirm the validity of this test. Thus, on the whole, it is difficult to establish the responsibility of the adrenals in the production of diabetes among Basedow cases.

"Such is not the case, however, when one looks up a possible rôle of the pituitary in this direction. The reported cases of coincident exophthalmic goiter, acromegaly, and diabetes afford firm support for this theory. Even clinically, there is a marked resemblance between the severe Basedowian diabetes cases and cases of pituitary diabetes. Pituitary diabetes may show itself in the absence of acromegaly. All authors are agreed that it is due to hyperthyroidism. Claude and Baudoin, in a series of researches, found that in a certain proportion of subjects — arthritic and obese cases — after meal time alone, glycosuria appeared after the injection of pituitary extract. Comparison of these cases with those of glycosuria following thyroid treatment in obesity is of interest in this connection. Clinically and experimentally, there is thus a considerable analogy between Basedowian diabetes and glycosuria, on the one hand, and pituitary diabetes and glycosuria, on the other.

"From the above it seems just to assume that in diabetes coupled with exophthalmic goiter two internally secreting glands may be tentatively held responsible; viz., the thyroid and the pituitary. Can one conceive that these two influences are simultaneously operative in the production of Basedowian diabetes? Such a combination seems not unlikely, in view of the close functional synergism existing between the two organs named. As for the more precise mechanism of the glycolytic process taking place, the question arises whether the hypophysis and thyroid cause, through insufficiency in their functions, some disturbance in virtue of which the sugar is no longer retained in the liver. If they act

TABLE II

Date	Urine		Boiling water injections in minims	Pulse	Diet
	Specific Gravity	Sugar			
December 5	1,036	Yes	30	150	One slice bread t.i.d.
December 6	1,036	Yes	30	160	Same
December 7	1,038	Yes	60	160	Same
December 8	1,034	Yes	60	154	Same
December 9	1,032	Yes	60	150	Same
December 10	1,038	Yes	30	138	Same
December 11	1,028	Yes	60	130	Same
December 12	1,024	Yes	30	130	Same
December 16	1,022	Yes	60	120	Same
December 18	1,020	No	..	112	Same
December 20	1,020	No	30	108	Two slices bread t.i.d.
December 23	1,032	Yes	30	104	Same
December 24	1,036	Yes	..	108	Same
December 28	1,030	Yes	60	104	Same
December 30	1,034	Yes	60	100	Same
January 1	1,026	Trace	..	100	Same

through the pancreas, is this action exerted through the intermediation of the sympathetic system or through a harmone? These are further problems in general pathologic physiology which the association of diabetes with exophthalmic goiter brings up for future solution."

At a time too soon for this newly acquired knowledge to have taken form in my mind, the second patient with the same combination consulted us.

Mrs. G., age 40, mother of five children, family history negative, and aside from the menses not appearing till her eighteenth year, the personal history, too, was negative.

In August of 1911, she became ill and on consulting a physician was told she had diabetes. This diagnosis was repeatedly confirmed by medical men to whom she subsequently appealed for relief.

The months which followed, she experienced the pronounced symptoms of the disease, even to a severe pruritis vulva. A year passed and the thyroid was seen to be enlarged, and within the few months which followed, appeared the exophthalmus together with the other unmistakable signs of hyperthyroidism. When first seen by us, November 14, 1914, she was a complete wreck; anæmic, hæmaglobin 40 per cent; skin bore a dirty waxy hue, a tinge not unlike that associated with pernicious anæmia. By restricting the carbohydrates in total we hoped to free the urine from sugar, and then to gradually reëstablish them within control of her tolerance. Up to December 2, little gain had been made, and the same night she developed an acidosis which for a time threatened a fatal coma. Whiskey, sugar, with enormous doses of bicarbonate of soda (two heaping teaspoons) in a glass of water every half hour for four hours, prevented, we believe, the fatal issue. By December 4, she was entirely over the attack, and the next day, December 5, the injections of boiling water were resumed. Table II was compiled from her daily evening condition.

The neck having become inflamed and tender, we were forced to discontinue the boiling water. However, a fair carbohydrate tolerance was established, with a proportionate decrease in her hyperthyroid symptoms. A gradually improving condition was noted up to January 20, when again the injections of boiling water were resumed. Dr. Laurence Selling who had charge of the laboratory work, reported the disappearance of the sugar content of the blood, and argued the same would follow with the urine when further destruction of her thyroid was accomplished. The days given below are from his table, and represent the last sugar detected in the urine prior to the thyroidectomy performed after a week of sugar-free urine.

TABLE III

Date	Sugar per cent	In Grams
January 22	0.8	1.6
January 24	1	22.5
January 28	1	18
January 29	0.6	13
January 30	0.3	7

February 6, two-thirds thyroidectomy.

February 7, acetone, diacetic acid and sugar were present.

Within the hour following the extirpation, a severe post-operative hyperthyroidism developed; failure in our coffer-damming we believe to have been the cause. The pulse rose to 190, and then for a time the action of the heart seemed but a mere thrill. At the end of the first twelve hours the symptoms of thyroid toxæmia began to subside, but at the end of the twenty-four hours acidosis developed and increased in severity till coma threatened. This was combatted as in the foregoing attack with the addition of the "sugar drip" as modified by Rockey. By the end of the first forty hours the patient was out of danger. The table of Selling shows that by February 8, diacetic acid and acetone were absent, but early in the day the specimen showed levorotation, while later in the day dextrorotation in a slight degree. Acetone odor from the breath was noticed at the same time. The levorotation was 0.2 per cent and the same specimen showed by fermentation test 1 per cent sugar.

February 12, sugar was again detected in the urine—1.3 per cent 13 grams.

February 13, sugar was again found in the urine —1.1 per cent 20 grams.

Within two weeks the goiter symptoms had vanished, her pulse having fallen into the 80's, and

with this came the return of what may practically be regarded normal carbohydrate tolerance.

Since the foregoing experience we have made an extensive review of all known conditions in the production of glycosuria, and from it, we feel that the glycosuria of hyperthyroidism is exclusive in producing the classical signs of diabetes mellitus.

The glycosuria occasionally associated with acromegaly and gigantism, Cushing ascribes to hyperpituitarism, and von Noorden differentiates this from true diabetes by attention to the marked variation of the former. Later, it was observed by Cushing that persons acquiring adiposity while suffering from unmistakable hypophyseal deficiency associated with destructive pathologic process, similarly showed a high, often an extraordinary, tolerance for sugars, and this seems to tally with all that has been observed with similar lesions of the thyroid.

Glycosuria has not been observed associated with lesions of the adrenals in a way to warrant a belief in there being a relation to this particular gland.

Opie[1] makes the statement that diabetes occurring in association with such conditions as arterial sclerosis, cirrhosis of the liver, exophthalmic goiter and acromegaly, is secondary to a lesion of the pancreas accompanying these diseases. Whether this statement is based on theory or actual findings he does not say. Our results with the two cases herein reported, would hardly favor this view.

If my enthusiasm may be pardoned, it is my earnest belief that the time is not far distant when many of the cases of diabetes will be passed from the internist to the surgeon for treatment, if not for actual cure. This I base on the fact that diabetes is as yet but poorly understood, and that coming research will reveal it to be the result of a hypersecretion of one or more of those ductless glands which, when so perverted, lowers the carbohydrate tolerance of the chemistry of the body.

And further, do I see the boiling water method of Porter successfully applied to hyperpituitarism and the destruction of the Gasserian ganglion in tic douloureux with results equally aseffective as it has given in exophthalmic goiter.

[1] Opie. Diseases of the Pancreas, second edition, p. 360.

MULTIPLE BENIGN AND MALIGNANT ADENOMA LIMITED TO THE SIGMOID FLEXURE OF THE COLON[1]

By HORACE W. SOPER, M.D., St. Louis, Missouri

THE literature of this subject is not extensive. Albu (1), Strauss (2), and Schreiber (3) each report 2 cases of benign multiple adenoma removed by means of the sigmoidoscope. Albu reports 2 cases of malignant degeneration of benign polypi in the sigmoid. One patient declined operation and returned 4 years later with a large cancer of the sigmoid. In the second case resection was done, with recovery.

In 1913, I (4) reported 7 cases of benign multiple adenoma of the sigmoid, removed by means of the snare and cautery. One case presented 6 polypi; the largest one had undergone malignant degeneration, and presented a roughened, cauliflower-like extremity.

Since that report, I have seen 10 cases of single adenoma of the sigmoid and 8 cases of multiple adenoma, all of which were removed by the snare and cautery. In 3 of the cases malignant degeneration of the extremity of a polyp had occurred. The reports of the cases of malignant degeneration follow.

Case A. Male, age 42, February, 1911. Had observed blood in the stool in small amounts for the past 2 years. No pain, no tenesmus. Three pedunculated growths, one in the ampulla recti, two in the beginning of the sigmoid, of hazel-nut size,

[1] Read at the meeting of the American Gastro-Enterological Association, Baltimore May 10, 1915.

were removed by the snare and cautery. One showed a roughened extremity, which proved to be malignant adenoma. The patient has been kept under observation since, and no recurrence of the growths has appeared.

Pathologists' reports by Dr. R. Buhman, Dr. D. L. Harris, and Dr. C. Klenk: malignant adenoma.

Abstract of report by Dr. D. L. Harris:

"In this case, it is not the gland as a whole which is involved, but rather individual epithelial cells seem to have acquired the property of independent reproduction. The result is that the glandular appearance is soon lost and the individual cells grow at random; columnar cells become cuboidal and round, and have extremely irregular nuclei.

"Sections from this tumor show enormous variations in the height and arrangement of the epithelial cells in a single field. In a single gland tubule one side will be made up of unusually tall, narrow, thread-like cells, while on the opposite side the cells will be flat, round, and massed in columns. In many places individual cells grow freely into the surrounding connective tissue. This is a malignant adenoma of the intestine."

CASE B. Male, age 41, February, 1912. Diagnosis made by sigmoidoscopy in a case of spastic constipation. No other symptoms. Two polypi were located at the entrance into the sigmoid, one pea-size, the second one hazel-nut size. Both removed by snare and cautery. The larger one showed malignant degeneration (Dr. R. Buhman).

CASE C. Female, age 39, July, 1913. She had observed a little blood in the fæces for the past 3 years. Upon sigmoidoscopic examination two polypoid growths were seen 8 inches from the anal margin. The pedicles were long and the two growths came together, so that the wall of the bowel appeared to be involved. A small piece was secured for microscopic examination, and was reported as malignant adenoma (Dr. C. Klenk).

Bowel resected, July 21, 1913, by Dr. H. G. Mudd. Excision and end-to-end anastomosis. The patient made a rapid recovery.

Subsequent frequent sigmoidoscopic examinations showed good union. No scar-tissue visible, and no contraction of the bowel.

Three pathologists examined the specimen with the following diagnoses: adenoma, Dr. D. L. Harris; malignant adenoma, Dr. C. Klenk; malignant adenoma, Dr. R. Buhman.

Without entering into the pathological problems involved, it is obvious that the adenomatous polyp exhibits a decided inclination to develop malignancy. Hauser (5), Albu (1), Schreiber (3), Strauss (2), Doering (6), and others emphasize this tendency. Von Wechselman (7) states that every malignant adenoma develops from a benign adenoma.

These growths are readily removed by means of the snare and cautery through the sigmoidoscopic tube. Even when malignancy develops in a pedunculated polyp, it is possible to destroy the growth completely without resorting to resection of the bowel.

The adenocarcinoma of the sigmoid grows slowly, and metastasis is late, yet the cases are rarely diagnosticated until obstruction is almost complete or the surrounding tissue is so involved that attempts at radical operation are futile.

Finally in the modern campaign against cancer, this field, now so accessible, appears to be neglected. Surely no other region of the body offers better opportunities for early diagnosis, prophylaxis, and treatment.

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THE CORRECTION OF NASAL DEFORMITIES BY MECHANICAL REPLACEMENT AND BY THE TRANSPLANTATION OF BONE[1]

By WILLIAM WESLEY CARTER, A.M., M.D., F.A.C.S., New York

FROM the point of view which I have maintained in my work on deformities of the nose, the framework is the basic, essential structure with which we have to deal. This framework, which constitutes the nasal arch, may be considered an arc built up of an indefinite number of segments assembled on a curved line in such a way as to retain their position when the structure is supported extraneously only at its two extremities. Broadly speaking the *displacement* of one or more of these segments produces a deformity amenable to the bridge-splint operation, while the absence of one or more of these segments would suggest the transplantation of bone to replace it. Upon these principles rests the foundation for my methods of treating the class of nasal deformities toward which my efforts have been especially directed.

The septum strengthens the nasal arch, but it does not support it, for it may be entirely removed without endangering this structure provided that its upper edge, which acts as the keystone of the arch, is left undisturbed. Several cases of depressed deformity of the nose have come under my observation which resulted from the submucous operation, the keystone of the arch having been destroyed either at the time of the operation or by a subsequent infection.

The proper use of a mechanical contrivance for the correction of a nasal deformity necessitates that we have already fixed in our mind not only the results which we wish to accomplish, but what is of far greater importance we must understand the mechanics of the apparatus employed. The lines of force exerted by a mechanical appliance are definite and invariable, and when it is applied the results obtained are fixed with mathematical precision.

The action of the bridge splint is intended to duplicate the forces employed by Nature in the development of the flattened nose of the infant into the more prominent organ of the adult. When it is applied in the case of a depressed deformity it corrects this by reversing the direction of the force that produced it. The use of this instrument presupposes that there remains in the nose a sufficient amount of bony and cartilaginous framework to sustain it in its proper position after the removal of the artificial support.

The bridge splint, with which many of you are already familiar, consists of two fenestrated, curved steel wings hinged together in the middle. The edges of these wings are padded with rubber and the distance to which they can be separated is regulated by a thumbscrew. To be used in connection with this bridge are two intranasal splints which are molded out of sheet gutta-percha at the time of the operation and made to conform to the roof of the patient's nose. These are attached to silk sutures which are threaded into large curved needles.

Thorough mobilization of the framework in old cases is essential and is accomplished by means of a specially devised chisel-forceps, a chisel for intranasal use, and the Adams forceps.

The chisel-forceps has a flat blade which is padded with rubber to protect the skin and when used rests on the outside of the nose. On the end of the other blade, and at right angles to it, is a narrow chisel. This blade is passed into the nose and is used to cut through the nasal bones near their attachment to the frontal. The depth to which the chisel can cut is regulated by a set-screw on the handle of the instrument.

The intranasal chisel is used for separating the nasal bones from the nasal processes of the superior maxillæ, or for splitting off a portion of the latter for use in building up the nasal arch. This instrument consists of a narrow chisel protected on either side by a

[1] Presented as a Candidate's Thesis to the American Laryngological, Rhinological, and Otological Society.

blunt guide. The shaft is slender and near the handle is a cross-bar to facilitate the turning of the instrument in splitting off the piece of bone.

The Adams forceps is used for general mobilization of the tissues.

In describing the use of the bridge splint, we will assume that we have a broad, irregularly flattened nose due to traumatism. The interior of such a nose is always badly deformed, the septum is crushed, and one or both nasal cavities fs obstructed. We will find that the nasal bones have been broken or disarticulated from their attachments to the frontal bone and that they override the nasal processes of the superior maxillæ, which may also be broken. The cartilaginous dorsum has become detached from the ends of the nasal bones and at this point there is a steplike depression. The intranasal condition is frequently the predominant cause of the patient's discomfort, and the fact that this too may be relieved by the bridge splint is one of the strongest points in favor of its use. If, however, we have a massive, irregular septum it is better to do a submucous operation before putting on the bridge splint. If the patient is under fourteen years of age, Gleason's operation is recommended instead of the submucous.

In such a case as I have described we must first completely mobilize the entire framework of the nose by means of the instruments I have mentioned. The bridge splint is then applied in the following manner: The sutures to which the intranasal splints are attached are passed from within the nose through the cartilaginous dorsum just below the ends of the nasal bones. By means of these sutures the splints are pulled up against the roof of the nose. The lower ends of the splints should lie just within the vestibules, and the upper ends partially beneath the nasal bones. The bridge, the wings of which have been well padded with gauze, is then placed over the nose. The sutures attached to the intranasal splints are passed through corresponding fenestræ in the bridge and the dorsum of the nose lifted to the desired height; they are then tied together over the hinge of the bridge. The bony side-walls are then moved nearer together by means of the adjustment screw; this narrows the base of the nasal arch.

It will be seen that the opposing forces applied by means of this instrument tend to construct a normal nose. It will also be observed that these forces equalize each other, and therefore the instrument is self-retaining; in fact, it cannot be easily displaced. It should remain on about two weeks, but the bridge should be loosened up each day and the spot on either side of the nose where the wings rest should be bathed with alcohol in order to guard against necrosis of the skin.

In bridge splint cases bony union occurs in three weeks, and the gaps between the bones are usually filled in six weeks.

If the septum is too short, which is frequently the case, it can be readily understood that it will hold the dorsum of the nose down when the attempt is made to raise it. In such cases the septum may be lengthened in two ways: First, by making a diagonal incision through the septum from the floor of one nostril upward to the roof of the other. Then when the bridge of the nose is raised the two segments slide partially by each other and the septum is lengthened without leaving a perforation.

By the second method the septum is built up in the following manner: By means of a sharp, two-edged knife a flap including a portion of the lateral cartilage is cut from the sides and roof of each nasal cavity, and the incisions are joined from side to side, under the dorsum of the nose. The flaps, being attached by their pedicles to the septum, are lifted up and fall together when the intranasal splints are supplied. We thus add materially to the height of the septum, which then supports the bridge in its elevated position. This method is particularly useful where there is a steplike depression at the ends of the nasal bones.

I have on several occasions used this method for correcting slight depressions of the cartilaginous dorsum without applying the bridge splint. When this is done the flaps are held in their proper position by means of crossed mattress sutures which pass through the dorsum of the nose.

My experience with the bridge splint during the past seven years has been most satisfactory. I regard it as the ideal method for treating both recent and old traumatic cases, lateral deformities, etc. In fact, its use is indicated in all of those cases where there is displacement (not destruction) of some of the primary segments of the nasal arch.

Some of my oldest cases have been under constant observation, and I can assure you that the good results obtained by this operation have been maintained, and in the case of children their noses have attained to the symmetrical proportions of normal adult organs. I would particularly recommend the use of this instrument in fresh fractures where there has been considerable crushing of the bony parts. In these cases it should be applied as soon after the injury as possible.

In the light of my experience in a large number of cases, I will say that this method of treating depressed deformities of the nose is founded upon sound mechanical principles, and it aims at the ideal in surgery; namely, to restore the form and function of this organ by the replacement of its own tissues into their normal position.

TRANSPLANTATION OF BONE

The limitations of the bridge-splint operation first suggested to me the idea of transplanting bone for the correction of those deformities due to a deficiency in the bony framework; a class of cases for which hitherto little or nothing had been done. A living tissue was chosen for the reason that in the opinion of the writer the introduction of foreign bodies into the tissues for the correction of a nasal deformity still remains a procedure of unfixed utility. And the healing in and permanent retention of these bodies in a fixed and satisfactory position is a matter of considerable doubt. Furthermore, foreign bodies introduced into the tissues invite infection and they cause disintegration and absorption of the surrounding tissues.

In general, we may say that depressed deformities in which there is a deficiency in bony framework are suitable for bone transplantation. This deficiency may be due to—

1. Congenital defects.
2. Traumatism, accidental or operative (submucous operations).
3. Abscess of the septum.
4. Destructive diseases, such as syphilis, lupus, and atrophic rhinitis.

The transplantation of bone into the tissues of the nose is an operation of extreme delicacy, and satisfactory results cannot be obtained unless the laws of antisepsis and asepsis are strictly observed. Infection destroys the life of the transplant and it either sloughs out at the time or is subsequently absorbed. Then too, if strong antiseptics are used during the operation, the cellular activity of the bone and the receiving tissues is impaired. After the first incision is made I use only physiological salt solution (9 gm. to 1,000 ccm.) freshly sterilized.

PREPARATION OF THE PATIENT

The patient should be in good physical condition. If the deformity is due to syphilis we must be sure that there are no active manifestations of the disease present, and that the Wassermann test is negative. If due to atrophic rhinitis the usual accompanying sinusitis should be attended to, and the hygiene of the nose improved as much as possible. Several hours before the operation the nose and face and the right side of the chest should be scrubbed with green soap and water, followed by alcohol and a wet bichloride dressing (1 to 5,000) applied. At the time of the operation the eyebrows are covered with collodion and both operative fields are painted with tincture of iodine.

The nose is first prepared for the reception of the transplant.

There are two points at which the incision may be made through which the tissues are elevated and the transplant introduced: (1) through a curved incision made between the eyebrows; (2) through an incision made from within the nose at a point corresponding to the lower edge of the upper lateral cartilage. Considerable discretion, however, should be exercised in selecting which method shall be used in a given case. The first method is preferable in the majority of cases; these include the most marked deformities and

those in which the nasal cavities are foul from old sinus suppuration.

A curvilinear incision, convexity downward, is made between the inner extremities of the eyebrows through the skin and subcutaneous tissues down to the periosteum. Through this the tissues are elevated by means of a special sharp elevator over the entire nose, and in some instances, where there is considerable scar-tissue, far out under the cheeks. The semilunar flap is then lifted up and a short horizontal incision is made through the periosteum just below the glabella. At this point the bone itself is incised in order to excite an osteogenesis, which will unite the transplant to the frontal bone. The so-called periosteum over the frontal bone is not an osteogenetic membrane, and is utilized in this operation merely to fix the upper end of the bone graft.

If the intranasal route is chosen, which may be done in cases of moderate severity and where the nasal cavities can be kept clean, the incision is made through the mucous membrane at the lower edge of the upper lateral cartilage and through this the tissues are elevated and the bone introduced. A pocket is also made toward the tip of the nose in which to place the lower end of the transplant.

The field, having been prepared for the reception of the bone graft, is covered with sterile gauze, and we then proceed to the next step in the operation, the removal of about two inches of the ninth rib on the right side. This is done with the costotome, the periosteum on the anterior surface only being preserved. This piece of rib is then split in its transverse diameter and the cancellous tissue scraped from the outer, periosteum-covered strip of compact bone. Recently I have attempted to imitate the shape of the nasal bones by making side wings to the dorsal strip of bone. This gives a better shape to the bridge and prevents the slight falling in which sometimes occurs on either side of the dorsal strip such as I have usually employed.

The transplant is then placed in its position in the nose; the lower end reaching nearly to the tip, and the upper end being anchored under the periosteum just below the glabella. The blood-clot which has already formed in the wound is not expelled, for this nourishes the bone temporarily and later favors osteogenesis. The initial incision is then accurately closed with horse-hair sutures and a collodion-and-gauze dressing applied. The sutures should be removed in three days.

In placing the transplant, either the convex or the concave surface may look forward, depending on the deformity. If the deformity is not corrected by one strip of bone, several pieces may be superimposed. If there is much scar-tissue, and especially if the deformity is extreme, lest the tension on the skin be too great, it is better to be content with establishing at the first operation a bony foundation firmly attached to the frontal bone upon which to build subsequently. At least six months should elapse before the second operation.

When all of the bony structure has been destroyed, and there is no support for the dorsal strip of bone, I support the latter by means of an inverted V-shaped pier made of two additional strips of bone, which rest on the superior maxillæ on either side of the nasal notch. In other instances I have used the bridge splint to support the transplant.

In one case I completely corrected the deformity by reversing the curves of two pieces of rib; the anterior strip being anchored under the periosteum over the nasofrontal process. The result in this case was particularly good.

In one case where the nose was absent, I first grafted the bone into the tissues of the arm, and at a subsequent operation grafted the flap containing the bone on to the face; when this had become united I severed the flap from the arm and shaped it into a fairly respectable nose through which the patient now breathes, and with which she is highly delighted.

Where only the cartilaginous dorsum is involved in the deformity, cartilage transplants may be used. These should be introduced intranasally. I have frequently used in these cases large bony or cartilaginous spurs removed submucously at the time the deformity is corrected. I have recently examined a case in which rib cartilage was transplanted two and one-half years ago.

The correction has been maintained and there has been no change in the size of the transplant, but it had not become fixed to the underlying bone.

The rib is selected for transplantation, as I stated in my first presentation of this subject, because it is suitable in shape, is conveniently located, its removal causes the patient little or no discomfort and it is quickly reproduced. Furthermore it is abundantly supplied with minute nutrient foramina.

The autoplastic operation, i.e., the use of the patient's own tissue for transplantation, is preferable to all others, because as I have previously pointed out, the constitution, i.e., the arrangement of the atoms in the molecule, is the same in both the transplant and the receiving tissues, so that there is no chemical antagonism between the two to interfere with the nutritive processes. These conditions would rarely be met, save in the tissues of the same individual. I have tried bone from another patient on two occasions without success. I consider the autoplastic operation the only one we are justified in doing.

The use of several small pieces of bone is preferable to large ones, for they are more easily nourished, and besides small fragments possess relatively greater osteogenetic power.

When introduced into the tissues, each particle of bone is surrounded by a serous pablum which nourishes it temporarily. This is followed by the development of new blood-vessels from the surrounding parts and the proliferation of the osteoblasts contained in the transplant. In a case where I did a second operation, two years after the first transplantation, I found the original transplant securely imbedded in the tissues and covered by a firm periosteum.

Bone transplanted into the soft parts, as into the nose, will give us a better idea of its individual characteristics than when it is used in filling in defects in the long bones; for in the latter situation it is being placed in its natural environment where its own characteristics will be confounded with those of neighboring tissues, namely, the periosteum and the bare ends of the injured bone.

The value of the periosteum and the ultimate fate of the bone transplant are subjects which have received considerable attention from writers on this subject, and the wide divergence of opinion leads me to believe that much that has been written is based upon conjecture rather than clinical observation. Or else it is due to a difference in technique and in the local conditions in the operative field which may have affected the vitality of the transplant.

Bone is a tissue comparatively slow in its metabolic processes; therefore time is an essential element in estimating the changes that occur when it is transplanted into another part of the body.

My work in this field is, as far as I know, the first systematic effort made to correct nasal deformities by transplanting bone. Some of my cases therefore are of standing long enough to enable one to draw conclusions. Furthermore, all of my work has been done upon human subjects and many of the cases have been under constant observation, so that conclusions drawn have direct practical value, and they are based upon historical facts and not upon prophecy, which would be the case if sufficient time had not elapsed since the operation, or if our experience had been limited to animal experimentation.

I have transplanted bone both with and without periosteum, and my oldest cases are of over five years' standing. A detailed account of these cases would serve no useful purpose, I will therefore offer the following conclusions which are drawn from clinical observation and from repeated X-ray examinations. In my opinion they show the true status of autoplastic bone transplantation.

If the wound becomes infected, the transplant may be expelled at once. If the infection is controlled by prompt and efficient means the transplant is probably dead and will in time be absorbed. But if the deformity was properly corrected it will remain so, as the absorption of bone is a slow process and it is replaced by connective tissue, cartilage, or bone which maintains the correction.

When live bone is properly and aseptically transplanted the results are as follows:

1. Bone *with or without periosteum* and free in the soft tissues is osteogenetic and also probably acts in an osteo-inductive capacity.

2. Bone uncovered by periosteum when connected with live, periosteum-covered bone is osteoconductive and osteogenetic, the points of greatest growth being where it comes in contact with the periosteum.

3. A periosteum-covered transplant connected with live, periosteum-covered bone establishes a firm bony union with the latter in three weeks, and it continues to live and grow practically unaffected by its change in environment. I have as yet noticed no overgrowth in such transplants and I believe that their development is regulated by the physiological requirements of the part.

While the periosteum is not necessary for the preservation of the transplant, it certainly adds to its vigor and growth and contributes to the success of the operation. In view of my experience in these cases I cannot subscribe to Macewen's views, that the periosteum is merely a limiting membrane and that it has no osteogenetic function.

In conclusion I will say that the transplantation of bone offers a very satisfactory means of relief for a class of nasal deformities for which hitherto little has been done.

BLOOD-PRESSURE IN FIBROMYOMATA UTERI

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THE literature on the relationship between fibromyomata of the uterus and the circulatory system is abundant, but a careful search showed only one reference to the blood-pressure found in these cases. Barrows (1) found that "none of these patients as a rule had a high blood-pressure and that the blood-pressure was practically not changed by the removal of the tumors themselves nor by the uterus together with the tumors." However, he gives no records on which he bases his conclusions. An investigation has therefore been made of the recent records of the Roosevelt Hospital Gynecological Division to see if any information could be obtained.

We took 148 consecutive cases of fibromyomata of the uterus in which blood-pressures had been taken. These embraced the years 1913 and 1914 and the first few months of 1915. A number of cases were found to be clearly cardionephritic and so were excluded. Of the 148, 55 (37 per cent) had a brachial blood-pressure of 120 mm. Hg. or under, with an average age of 34.9 years, and 62 (41.8 per cent) had pressures from 121 to 140 mm. Hg. inclusive, with an average age of 35.8 years. This made a total of 117 cases (78.8 per cent) with a blood-pressure of 140 mm. or under, and an average age of 35.9 years. As these cases were thought to be normal variations, only the remaining were given further study.

The 31 over 140 mm. blood-pressure had an average age of 43 years. Letters were sent to these patients, and as a result, 22 came to see us. Most of the 22 had large fibroids, and at operation these tumors were removed, while in most cases either a supravaginal or a complete hysterectomy was performed. On return, the patients had general physical and pelvic examinations, urine analyses, and brachial blood-pressures.

FINDINGS

1. Urine: Hyaline casts were found in one specimen; a trace of albumin in two other cases, while in a fourth case the family physician has found traces of albumin several times since operation. A fifth case gave Fehling's reduction.

2. In the cases having high blood-pressure slight cardiac enlargement was usually found, but only in the glycosuria case was there heard a murmur.

3. Three cases had unchanged blood-pres-

Hospital Number	Date of Discharge	Examination Date	Hospital Blood-Pressure	Examination Blood-Pressure	Age	Urine	Heart, Etc.	Pathology Operation.
2541	6-19-13	5- 1-15	150	140	31	Negative	Negative	Several small fibroids. Myomectomy.
2633	8- 4-13	4-16-15	165	190	42	Negative	Negative	Grape fruit size. Supravaginal hysterectomy.
2638	8- 6-13	5- 1-15	190	235	47	Hyaline casts	Large heart; œdema; dysp.	Large intramural. Complete hysterectomy.
2639	8- 7-13	5-25-15	145	160	25	Negative	Negative	Few small fibroids. Myomectomy.
2795	10-14-13	4-16-15	150	200	29	Albumin, faint trace	Negative	Multiple fibroids. Supravaginal hysterectomy.
2851	11-17-13	5-28-15	165	150	50	Negative	Negative	Many fibroids. Complete hysterectomy.
4044	3- 9-14	4-15-15	190	255	40	Albumin, faint trace	Negative	Many fibroids. Supravaginal hysterectomy
4227	5-13-14	4-14-15	150	170	45	Negative	Negative	Many fibroids. Supravaginal hysterectomy.
4712	11-25-14	4-19-15	145	140	32	Nephritic history	Negative	Several submucous. Supravaginal hysterectomy.
4592	10-14-14	4-21-15	180	140	43	Negative	Negative	Many large fibroids. Supravaginal hysterectomy.
4612	10- 5-14	4-16-15	150	150	45	Negative	Negative	Large intramural. Supravaginal hysterectomy.
4682	11-15-14	4-22-15	150	120	42	Negative	Negative	Moderate size. Supravaginal hysterectomy.
4587	10-11-14	4-15-15	165	200	36	Negative	Negative	Large fibroids. Supravaginal hysterectomy
4677	11-11-14	5- 1-15	175	190	49	Negative	Negative	Several fibroids. Supravaginal hysterectomy.
4860	1-22-15	4-14-15	160	165	38	Negative	Negative	Many fibroids. Complete hysterectomy.
4841	1-15-15	4-16-15	155	180	46	Fehling's positive	Systolic at apex	Many large fibroids. Supravaginal hysterectomy.
4829	1-10-15	4-15-15	185	170	49	Negative	Negative	Many intramural Supravaginal hysterectomy.
2557	6-11-13	6- 1-15	160	160	31	Negative	Negative	12 walnut size. Myomectomy.
4959	3- 2-15	5-27-15	145	170	37	Negative	Negative	Many fibroids. Complete hysterectomy.
4944	2-25-15	6- 4-15	145	145	56	Negative	Negative	Several intramural. Complete hysterectomy.
5006	3-19-15	4-15-15	195	155	50	Negative	Negative	Many fibroids. Supravaginal hysterectomy.
5011	3-22-15	4-22-15	145	135	34	Negative	Negative	Many large fibroids. Supravaginal hysterectomy.

sure; 11 had an increase from 5 to 65 mm., and 8 had a decrease from 5 to 40 mm. Hg.

We therefore find —

1. That no definite relation is shown between fibroids and increased blood-pressure.

2. That the removal of the tumor, or the tumor with the uterus, has no definite effect in those cases which happen to have an increased blood-pressure.

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THREE HUNDRED TWENTY-FOUR CONSECUTIVE CASES OF APPENDICITIS, OPERATED UPON WITHOUT A DEATH

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IN a period of four and one-half years, January, 1911, to July, 1915, there have been operated upon at the Naval Hospital at Norfolk, Virginia, 324 consecutive cases of appendicitis without a death. Practically all these cases were operated upon either by Dr. H. F. Strine of the Navy, by the writer, or by some other member of the hospital staff under their supervision. In this series there have been 183 acute cases and 141 cases classified as chronic. Under the acute cases are included the commonly recognized varieties of the acute catarrhal, acute suppurative, gangrenous, and perforative types. Cases with abscess formation are also included under this head. Under chronic cases are included the interval-operation cases, the so-called relapsing and recurrent types, and also that considerable class whose symptoms are referred almost entirely to the stomach and which are not infrequently diagnosed as ulcer. Under this head also are included that not uncommon class of cases now recognized as chronic intestinal stasis due to partial obstructions produced by adherent appendices or by adventitious bands and membranes in the region of the appendix. In this latter class appendectomy has always been done in addition to plastic correction of obstructions produced by such membranes and bands. For this reason these cases are included under the head of chronic appendicitis.

A great majority of the acute cases reached the hospital early, but in many cases an early transfer was not possible. Cases occurring on the smaller cruisers, torpedo boats, in the submarine flotillas, and on sea-going tugs, when such vessels are at a distance from port, cannot, in the nature of things, be transferred to the hospital for many hours or days after the diagnosis has been established, and such vessels do not afford facilities for operating. Acute cases occurring on the larger vessels under similar circumstances are commonly operated upon on board as soon as a diagnosis is made. We have been fortunate in not losing any of these late cases but attribute this result largely to the fact that in nearly every case an early diagnosis was made and food and purgatives were withheld from the beginning. In other words, in practically all those cases that could not be transferred to the hospital at once the Ochsner treatment was instituted early and faithfully carried out. The fact that in this entire series there have been no residual abscesses except moderate collections of pus in the immediate vicinity of the wound of operation not requiring secondary incisions for their evacuation, goes to show that there has not been any great amount of diffusion of the infection through the setting up of excessive peristalsis.

Of the 183 acute cases, 28 were drained: 9 for gangrene of the appendix, 12 for a more or less diffuse peritonitis, and 7 for abscess. In 2 of the abscess cases the appendix was not removed.

Every case presenting acute symptoms has been operated upon as soon as the patient and operating room could be prepared. The preparation of the patient in these cases consists of the giving of a single low enema and of dry-shaving the skin, or shaving with the use of alcohol, if preferred. Nitrous oxide and oxygen has been the anæsthetic in the great majority of the cases or these two with the aid of ether, especially in alcoholics. The skin is painted with benzine and, when this has dried, with a 2.5 per cent tincture of iodine. The McBurney incision has been employed almost to the exclusion of any other. Occasionally the ordinary McBurney incision has had to be enlarged by opening the sheath of the rectus muscle. By opening

the rectus sheath obliquely upward or downward as conditions indicate, an opening of sufficient length for all purposes may be obtained. In a small number of cases the Battle incision has been used, drawing the muscle toward the midline.

The appendix has been removed in all cases except two of the abscess cases. For the past year and a half we have not inverted the stump, believing it entirely unnecessary. The meso-appendix is tied off, usually with a single ligature, the base of the appendix is clamped, ligated with No. 2 chromic catgut in the groove thus formed and the stump disinfected with carbolic acid. In several cases in which a secondary operation had to be done for other causes it was found that no sign of the stump was present and no adhesions had been formed following simple ligation. It is apparently of the greatest importance after the use of iodine to cover the skin around the incision with tetra cloths or towels, fastening these to the margin of the incision with appropriate clamps. In a number of clean cases, in which this precaution was not taken, we have seen post-operative adhesions which required secondary operation. We believe the contamination of exposed intestine with the tincture of iodine to be a fruitful source of such adhesions.

In cases of gangrene the appendix is always removed and an attempt is made to completely bury the stump with Lembert sutures of catgut, taking care to insert the stitches in the healthy wall of the cæcum. In such cases a cigarette drain is always employed.

In all drained cases non-absorbable sutures should never be used, for such material is not infrequently the cause of persistent sinuses.

In cases with local or diffuse peritonitis the pus that presents itself in the wound is quickly mopped out with gauze on sponge holders, the appendix crushed, ligated, and cut away, and one or more cigarette drains inserted. No attempt is made to wipe off the intestine or to cleanse any part of the peritoneal cavity except that in the immediate vicinity of the wound. No irrigation with saline, peroxide of hydrogen, or other fluid is attempted. One drain is usually inserted toward the pelvis and a second to the base of the appendix. These cases stand prolonged operations badly; the quicker the operation, other things being equal, the better chance the patient has for recovery. The kind of drain does not seem to be a matter of great importance. For the past year and a half cigarette drains have been used exclusively, but prior to that soft rubber drainage tubes were employed. The cigarette drains are commonly left in place four or five days without being disturbed, depending upon the severity of the case. Drainage tubes are always removed within forty-eight hours and another tube or wick inserted if necessary. If left in place for longer than forty-eight hours or thereabouts drainage tubes not infrequently cause pressure necrosis and fistula. In cases in which the omentum is extensively thrombosed and discolored, that portion of it thus involved is ligated in sections and removed. We have been fortunate in having no case of pyelophlebitis in this series and we have also been fortunate in having no residual abscesses except in the immediate vicinity of the wound of operation. All such abscesses have been opened by simply enlarging the wound and gently exploring with the finger. In one case complete intestinal obstruction developed on the thirteenth day. An enterostomy was done through a secondary rectus incision, a large catheter inserted into the distended intestine according to Kader's method, the end of this catheter led out through the original incision, and the rectus wound closed. The patient recovered without fistula and without the necessity of further operation.

Drainage is being employed much less frequently now than three or four years ago. Cases in which the inflammation is confined to the appendix, even those with extensive plastic exudate and moderately turbid fluid are not drained. We have had no occasion to regret the omission of the drain in such cases.

In operating upon cases in which abscess has formed, the McBurney incision is commonly used. This incision not infrequently has to be enlarged by opening the rectus sheath. The abscess is carefully walled off with gauze and gently opened. Not infrequently a conglomerate mass of intestine and omentum presents itself, to which there

seems to be no head or tail. By boring into this with the finger, thus opening the abscess, and mopping away the pus with gauze, the various elements can be identified and the appendix removed in a great majority of cases. In most of these cases and in many of the acute suppurative cases without abscess formation, the appendix can be gently dug out of a mass of adhesions without paying any especial attention to its mesentery, for in a large percentage of these cases the vessels of the meso-appendix are thrombosed and do not require ligation. After the abscess cavity has been thoroughly cleansed, two or three cigarette drains are inserted, the protecting gauze pads removed and the wound is partially closed.

In all acute cases, especially those in which drainage is to be employed, it is of great importance to make the incision as small as is consistent with thorough work, and in these cases the muscle-splitting incision is of special advantage in order to avoid post-operative hernia or weakening of the abdominal wall. In these cases the muscles and other elements of the abdominal incision should be protected from infection in so far as it is possible. Before closing the wound it is well to swab it thoroughly with tincture of iodine. In some especially virulent cases we have applied carbolized vaseline to the wound with apparent benefit, in that the not uncommon sloughing of fascia and muscle seemed to be prevented or lessened thereby.

In all acute cases, especially those requiring drainage, the post-operative treatment is of the greatest importance. Except in the mildest cases nothing is given by the mouth for twenty-four hours, when sips of hot water are allowed if everything is going well. At the end of thirty-six or forty-eight hours an enema is given. Purgatives are avoided for several days at least.

All cases with any degree of peritonitis are placed in the Fowler position upon reaching the ward, and protoclysis by the Murphy drip begun. The saline is allowed to flow very slowly, drop by drop, and is continued until 1,500 or 2,000 cubic centimeters have been absorbed or until it is beginning to be expelled. Nothing is allowed by mouth in the severer cases until peristalsis has become reëstablished and abdominal distention has disappeared. This may require several days, and in the meantime protoclysis is continued.

If vomiting occurs, or if for any reason the patient does not seem to be doing well, the stomach is washed out until the fluid returns clear and this procedure is repeated as often as may be necessary, occasionally being done four or five times in twenty-four hours. If distention and absence of peristalsis persist, repeated enemas are given, each containing one or two drams of turpentine. Such enemas may be given every hour for five or six hours, and after a rest of a few hours this course may be repeated if necessary. By persevering in this treatment recovery will frequently ensue when almost despaired of.

The recovery of the 183 consecutive cases of acute appendicitis herein reported is attributed to the following factors:

1. Early diagnosis and early transfer to hospital in a very large proportion of cases.

2. The avoidance of food, drink, and purgatives, especially the latter (the Ochsner treatment), in a large percentage of the cases that could not be immediately transferred.

3. Immediate operation in all cases presenting acute symptoms and in every case in which the acute symptoms had suddenly subsided.

In contrast to the small incision employed in the acute cases the incision in the chronic cases should always be of ample size to permit a thorough exploration, not only of the region of the appendix but of the cæcum, the ascending colon, and the terminal portion of the ileum as well.

It is now definitely established that many cases which were formerly diagnosed as chronic appendicitis are not due to inflammation of the appendix but to chronic obstructions of the terminal ileum or of the ascending colon by certain adventitious bands and membranes. To properly correct such conditions incisions of considerable length are necessary. A four or five inch vertical incision to the right of the umbilicus, displacing the rectus muscle outward, seems to fulfil all requirements. Such an incision may be easily extended upward or downward as indicated.

DEPARTMENT OF TECHNIQUE

A METHOD OF DEMONSTRATING BACTERIA IN URINE BY MEANS OF THE CENTRIFUGE

With Some Observations on the Relative Value of Examinations by Culture or Stained Sediment[1 and 2]

By E. GRANVILLE CRABTREE, M.D., Boston
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WITHIN the past year my attention has been called to the value of stained urinary sediments as a control to cultural evidence in the diagnosis of urinary infections. Obvious lack of correspondence between the clinical picture of urinary infection and repeated negative cultures from the urine indicate that routine cultures made on a single variety of media may be misleading. A large bacterial flora is known to exist in urine. Many of these bacteria require for cultivation special media and anaërobic conditions not provided by routine cultural methods. To be sure many varieties of bacteria found in urine are not pathogenic, yet the fact remains that our knowledge of their significance is limited.

It is with the hope of presenting a simple method of demonstrating the presence of bacteria, including the tubercle bacillus, in the urine, and of emphasizing the clinical importance of stained preparations made directly from the urine as a control to routine cultural examination, that this communication is made.

Numerous methods of demonstrating tubercle bacilli in excretions of the body have been devised. One hesitates to add to the list since guinea-pig inoculation must be considered the final test in all doubtful cases. Guinea-pig inoculation, however, necessitates a delay, which, in some instances, may be insignificant, but which in others often allows time for the appearance of lesions in other organs of the body, particularly in the genital organs in males.

When one considers the extreme rarity of negative findings from guinea-pig inoculation where a tuberculous lesion exists in the kidney, and the comparatively small amount of urine commonly injected into the pig, he is convinced that tubercle bacilli must be present in the urine in sufficiently large numbers to enable him to arrive at an immediate diagnosis were it possible to concentrate the bacilli in a sufficiently small sediment. In the Massachusetts General Hospital we inject twenty minims of non-centrifuged urine in making guinea-pig inoculations for tuberculosis. In those cases in which repeated inoculations have been made from the urine of the same patient, lack of agreement in results has been extremely rare. One marvels at the accuracy of the test and likewise at the ability of the pig to produce the evidence even though no effort is made to concentrate bacilli in the urine injected. The urine from patients with tuberculous renal lesions must be generously and quite uniformly laden with tubercle bacilli.

The chief obstacles to the demonstration of tubercle bacilli in urine, by staining methods, are pus and detritus and the density of the bacillus. Tubercle bacilli are of almost the same density as urine. Only those bacilli which are entangled in shreds of mucus or are swept down by pus-cells are to be found in sediments obtained by the ordinary centrifugalization; the majority of the bacilli are left floating in the urine above.

By taking advantage of this marked difference in density between tubercle bacilli and pus it is possible to concentrate the bacilli contained in a considerable amount of urine into a small sediment, in cover-glass preparations from which bacilli will be found in large numbers unmasked by any considerable number of cells.

The procedure is simple but requires a first class centrifuge, preferably an electric centrifuge

[1] Dr. A. E. Steele of the Pathological Laboratory of the Massachusetts General Hospital called my attention to overgrowth of other bacteria by bacillus coli occurring in mixed infections of the urine. This occurrence leads to the finding of a predominating growth of this organism in the majority of mixed cultures. Within the present year (1915) Scheidmantel and Lustgarten *Muenchen. med Wchnschr.*, 1915, i, 1778 and 1922, and Manneberg observed that bacteria are found more frequently in smears from sediment than in cultures from the urine.

[2] As far as I know the method here described of concentrating bacteria by discarding pus from urine is original. It was suggested by observing Dr. J. H. Wright separating blood-platelets from blood by means of the centrifuge.

such as is used in blood work. A less powerful machine may be used but this necessitates a much longer time to throw down the bacteria. In the larger hospitals a suitable high-power machine is usually available.

My technique is as follows: If the urine contains considerable pus, centrifuge for one to two minutes at the lowest speed. The bulk of the pus and detritus will be thrown down in a heavy sediment leaving a somewhat cloudy urine above containing a few pus-cells and the majority of the bacilli. Decant the urine into a clean tube, discard the sediment, and centrifugalize the urine at high speed *until is is clear*. This step requires 15 to 30 minutes. The urine may be then decanted and the tube containing the sediment refilled with partly clarified urine and replaced in the centrifuge. In this way the contents of two or more tubes of urine may be concentrated into a single small sediment. Pour off the urine, invert the centrifuge tube on a towel and drain off the last drops. A fairly dry small sediment will be obtained which can be removed with a loop, and cover-glass preparations made, or cultures planted.

In those urines which contain but little pus, experience has shown that preliminary centrifugalization is unnecessary. The important step in the procedure is to centrifugalize the urine *until clear* to ensure deposit of the bacilli.

By the above method tubercle bacilli can be obtained from the urine in practically all patients with renal tuberculosis in numbers sufficient for diagnosis, and in most cases in surprisingly large numbers. This is especially true where the specimen of urine is obtained from the pelvis of the kidney. In examination of bladder urine it is advisable to concentrate the bacilli from more than one tube of urine into the same sediment since tubercle bacilli are apt to be present in bladder urine in smaller numbers than in urine from the diseased kidney on account of dilution by urine from the actively secreting sound kidney.

The danger of mistakes in diagnosis arising from any method of demonstrating tubercle bacilli by staining in sediment must be remembered. The chief danger is contamination from the smegma bacillus, which may inhabit the deep urethra in the male and the anterior portion of the urethra of the female. There is little evidence to indicate that this bacillus is ever present in the bladder except as accidental contamination carried there by the catheter.

The number of organisms to be found in the bladder urine from this source is necessarily small and negligible where large numbers of tubercle bacilli are demonstrated, as is done in the procedure just described. The smegma bacillus is not an inhabitant of the renal pelvis and the chance of accidental contamination at this remote distance is inconsiderable.

My experience with the centrifuge as the means of demonstrating tubercle bacilli, over a period of nine months with a total of 55 cases, has been satisfactory. The findings have been controlled by guinea-pig inoculation. I have dealt only with catheter specimens or urine from the bladder or from the kidney. I have made no erroneous diagnoses save in two abnormal renal conditions with tuberculous abscess formation which had not entered the pelvis of the kidney. Guinea-pig inoculations were also at fault in these cases. In two other instances I have been compelled to withhold an opinion even though a few acid-fast bacilli were found. A guinea-pig inoculated from the unused portion of the sediment showed tuberculosis in one of the two cases. In the other case no diagnosis could be made, either from stained sediment or guinea-pig inoculation at the time the patient was seen. Three sets of guinea pigs which had been inoculated from right, left, and bladder urine showed disagreement. At the first inoculation the pigs from bladder and both ureters were negative. At the second inoculation the bladder was positive and both ureters negative and finally the left ureter was positive and the bladder and right ureter negative. Tubercle bacilli were found once in three attempts from the bladder urine. At the end of six months the patient returned with a definite picture of left renal tuberculosis. Large numbers of bacilli were found in the urine from the left kidney. The diagnosis of left renal tuberculosis was made and confirmed at operation.

In a similar way, the absence of tubercle bacilli in urine obtained from the supposedly sound kidney has been confirmed by guinea-pig inoculation in all cases examined to date.

A second possible source of error which must be borne in mind in urinary examinations by staining methods is the centrifuge tube. The tubes used should be above suspicion of containing acid-fast organisms derived from any source of contamination. The two chief sources of such contamination are reagents used including water and the use of a centrifuge tube in which a tubercle-bacillus-laden urine has previously been examined. In as much as there is no occasion to wash sediments in the above-described method

the centrifuge tube is the only element of danger worthy of consideration. I thoroughly cleanse the tube with water and a cotton swab, rinse in concentrated sulphuric acid, then with water and dry the tube with a sterile sponge. If carefully done this cleansing is sufficient.

In performing the Ziehl-Neelson stain the cover-glass preparation should be decolorized by exposure for 30 seconds to 30 per cent nitric acid followed by alcohol. Tubercle bacilli will not be decolorized by this treatment if the carbol fuchsin stain has been well fixed by steaming for two minutes, while other acid-fast bacilli will not resist the strong acid.

I wish also to emphasize the value of stained sediments in the diagnosis of non-tuberculous infections of the urinary tract. Bacteria can be obtained from infected urines in large numbers by first removing the pus through throwing down the bacteria by centrifugalization of the urine at high speed *until the urine is clear*. By performing the gram stain, and the Ziehl-Neelson where indicated, the presence of infection is immediately determined and sufficient information as to the varieties of bacteria present is obtained to indicate proper cultural procedures. Contamination is immediately recognized as distinct from infection by the number of bacteria obtained.

The clinician is frequently struck by obvious inconsistencies in cultural reports from repeated examinations of the same patient's urine. This lack of conformity is the result of a number of factors over which the bacteriologist has no control, unless sufficient urine and time to make extensive cultures on a variety of media are at his disposal. The most important of these factors are: (1) Unsuitable media and anaërobic requisities; (2) the presence of formalin in instruments; (3) chromogenic properties of certain bacteria; and (4) overgrowth.

The marked tendency of certain varieties of bacteria to overgrow other forms is well known. The colon bacillus is the commonest offender in this direction. The result is often a report from the bacteriologist of a predominant growth of bacillus coli when the predominant organism in the fresh bladder urine may not be that organism. An instance of the occurrence of this error is a patient recently operated on at the Massachusetts General Hospital by Dr. Hugh Cabot. The patient had had recurrent phosphatic calculi in the bladder. His physician insisted that the urine had been constantly acid in reaction although one would expect a coccus infection in an alkaline urine with recurrent phosphatic calculi. The urine was stated to be acid in reaction and cultures had been reported as showing a growth of bacillus coli. When the patient entered the hospital his urine showed acid reaction in a specimen which had stood six hours, and cultures were reported as a predominant growth of colon bacilli. Freshly passed urine, however, was alkaline and stained sediments showed a mixed infection of staphylococci, streptococci, and gram-negative bacilli with the cocci predominating. The stone was crushed. The urine acidified with cultures of bacillus bulgaricus and at the end of ten days the bladder was free from encrustations.

Relatively unimportant chromagenic bacteria such as bacillus pyocyaneus, a transitory infection of the urinary tract of low pathogenicity, often, by the color of the colonies and the rapidity of growth obscure more significant permanent infections.

Unsuitable media or lack of anaërobic conditions may result in a failure to recognize some of the more rare varieties of bacteria occasionally met with in urinary infections. A stained sediment will show the presence of bacteria and proper cultural proceedings can be taken.

Braasch has emphasized the possibility of formalin sterilization of small amounts of urine obtained through ureteral catheters which have been sterilized by formalin. Sufficient of the antiseptic is washed down from the catheter to inhibit growth in cultures. I have also observed instances of no growth in cultures taken from bladder urine, in cases where hexamethylenamine has been used, but infections were demonstrated by cultures from the urine obtained from the kidney pelvis.

I do not wish to be understood to imply that cultural examination of the urine in infections is of less significance than the evidence produced by cover-glass preparations from sediment. Stained sediments serve to distinguish true infections from contaminations, show something of the nature of the infecting bacteria, show the predominating organism in mixed infections which is not accurately demonstrated by cultures in some cases, and demonstrate the presence of unusual bacteria which are not found by routine cultural examinations.

There is an interesting group of the more rare forms of bacteria, particularly anaërobes, to be found in urine. Little is known about their significance as infecting organisms in the urine. I have met with many such varieties of bacteria either alone or in mixed cultures and often in

association with tubercle bacilli. There can be no doubt that the colon bacillus is by far the most common and important organism concerned in infections of urine, yet its frequency of occurrence is overestimated by many clinicians and in many cases other varieties of organisms are overlooked. A step will be made toward specific treatment of urinary infections when other forms of bacteria are recognized and their pathogenicity in the urinary tract determined.

ARTIFICIAL LEVERAGE IN THE REDUCTION OF FRACTURES

By HERBERT GIFFORD, M.D., Syracuse, New York

THERE are some fractures that are fairly amenable to reduction by the unaided hands of the operator if advantage be taken of muscle balance and the natural leverage provided by the neighboring parts of the skeleton; there are others in which, because of dense œdema, impaction, or muscle pull, those means, unaided, are no more good than faith healing. Some of the latter type of fractures will be mentioned in this paper and a description will be given of the few simple but efficient instruments used and the technique employed, as evolved from the author's experience as a fracture surgeon.

The clamp (Fig. 19, *a*) is like the common quilting clamp, but with a six to ten inch jaw, of malleable iron, and if one be not too particular regarding appearance, may be obtained at any well-stocked hardware store. The other pieces shown in Fig. 19 (*b*, *c*, and *d*) are wood, the pad pieces suitably grooved and bevelled to prevent injury of the soft parts, and in emergency can be easily made by anyone. In use the clamps are padded with cotton or sheet-wadding.

Perhaps the matter may best be made clear by a few typical cases.

Case 1. *Straightening a long bone.* W. G., age 6, fell while roller-skating, sustaining the injury depicted in Fig. 1. For nearly three weeks he was under the care of a physician who kept telling the mother that the deformity was due to a swollen muscle which would soon subside. Finally, the mother became thoroughly alarmed and took the lad to her family physician, Dr. Stewart Bibbens, through whose courtesy he came under the writer's observation. On the twentieth day after injury, the technique shown in Fig. 2 was used under anæsthesia, with the result shown in Fig. 3.

The cases of fracture near the elbow-joint, so commonly seen in children, are in the writer's experience almost invariably separations, more

Fig. 1.

Fig. 2.

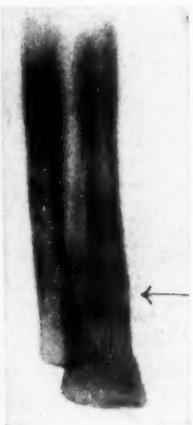

Fig. 3.

Fig. 1. X-ray showing facture of long bones, Case 1.
Fig. 2. Showing technique used to correct deformity.
Fig. 3. Shows the result of applying the technique shown in Fig. 2.

Fig. 4.

Fig. 5.

Fig. 4. Fracture at elbow-joint, Case 2.
Fig. 5. Radiograph one week after injury and reduction; deformity scarcely affected.

Fig. 6.

Fig. 7.

Fig. 6. Shows technique of reducing fracture at the elbow-joint.
Fig. 7. Result of procedure.

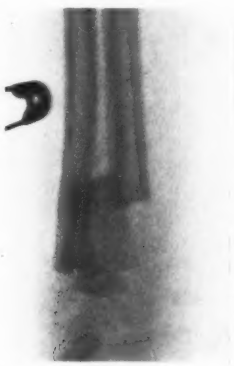

Fig. 8.

Fig. 9.

Figs. 8 and 9. X-rays showing fracture in Case 3.

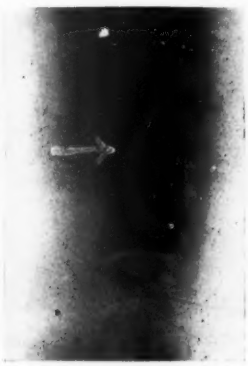

Fig. 10.

Fig. 11.

Figs. 10 and 11 show result of reduction.

or less pure, of the distal epiphysis of the humerus. Some are incomplete; others, complete, are not displaced; others, displaced, especially if seen early, say within an hour or two, are fairly easy to reduce; others may be exceedingly difficult, as in Case 2.

CASE 2. *Lower end of humerus.* J. W., age 5, patient of Dr. F. L. Scanlan, fell short distance, on July 1, sustaining the lesion seen in Fig. 4. After 24 hours, the entire elbow region was greatly swollen, and had the consistency of India rubber. The skeleton was nowhere palpable. The doctor and I tried strenuously to effect a reduction under chloroform, and as the case resembled closely several others in which good results had been obtained with no greater effort, overconfidence overruled caution, and no confirmatory radiograph was made at the time. A radiograph taken a week later, however, owing to the persistent swelling and deformity, showed that the displacement had been scarcely affected (Fig. 5). On

Fig. 12. Shows technique used in reducing Colles' fracture, Case 3.

Fig. 13.

Fig. 14.

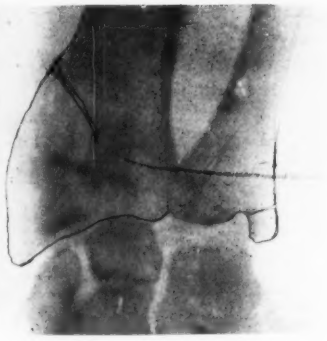

Fig. 15.

Fig. 13. Colles' fracture, lateral displacement, Case 4.
Fig. 14. Showing application of clamps.

Fig. 15. Result of application of clamps for reducing Colle's fracture.

July 8 (eighth day) the technique illustrated in Fig. 6 was used under anæsthesia, with the result shown in Fig. 7.

CASE 3. *Colles' fracture, backward displacement.* H. G., age 5, a very fat little girl, was struck by a motorcycle on May 28, receiving a fracture substantially as depicted in Figs. 8 and 9. Three separate attempts, under anæsthesia, had been made by conscientious and skillful general surgeons to reduce this fracture. On the twelfth day after injury, she was again etherized, and the technique shown in Fig. 12 was used. The results are seen in Figs. 10 and 11. Considerable maneuvering was necessary to detach the almost solidly healed fragment before it could be shifted over into place. No harm was done the soft parts.

CASE 4. *Colles' fracture, lateral displacement.* E. H., age 21, patient of Dr. W. J. McNierny, on December 6, 1914, fell from scaffold and received the fracture shown in Fig. 13. Reduction had been attempted under ether at one of the largest Syracuse hospitals, of which the mem-

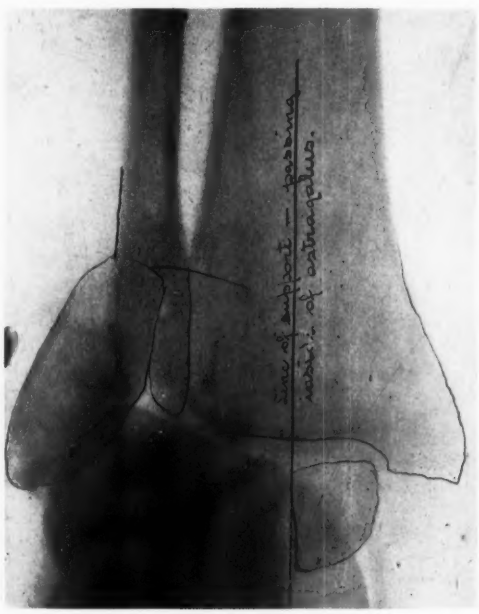

Fig. 16. Shows Pott's fracture, Case 5.

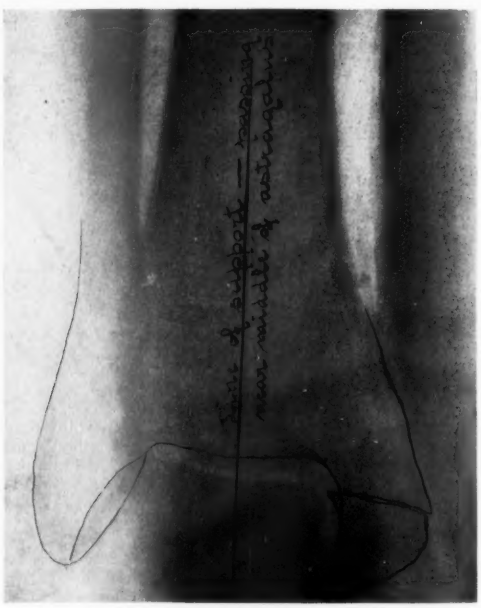

Fig. 17. Shows result of application of clamp, Case 5.

Fig. 18. Shows application of clamp, Case 5.

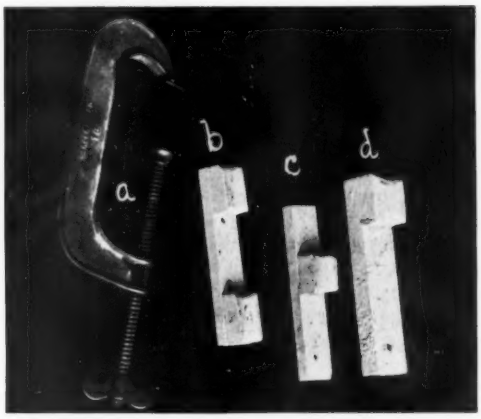

Fig. 19. *a*, Common quilting clamp; *b*, *c*, and *d*, grooved and beveled wood pad pieces.

bers of the staff rank high as general surgeons, but the persistent pain and deformity were so severe that the patient left the hospital and consulted Dr. McNierny. A radiograph (Fig. 13) made at this time (sixth day) showed the radial fragment displaced half a diameter, the ulnar styloid a full diameter, outward. Under ether, the clamps were used as in Fig. 14. The results are shown in Fig. 15.

The distal fragment in Colles' fracture, while being forced home in either direction, shows a queer tendency to sheer off at right angles to the plane of procedure. To develop this point with illustrative cases might make this paper unnecessarily tedious, but it is well to state that this aberration should be forestalled by a second clamp tightly placed at right angles to the plane of reduction, as illustrated in Figs. 12 and 14.

CASE 5. *Potts' fracture.* Mrs. M., age 72, patient of the Drs. Van Lengen, on February 18, by a slight misstep, sustained the lesion shown in Fig. 16. Six hours later, she was anæsthetized and reduction was attempted by Dr. Frederick W. Van Lengen, who weighs 265 and is one of the strong men of the Syracuse Turn Verein. The radiograph (Fig. 16), made next day, discloses plenty of reason for the difficulties encountered. The inner malleolus, carried a full diameter outward, had engaged in the ankle mortise formed by its undetached base. On the second day after injury, the technique illustrated in Fig. 18 was applied under chloroform, when, with strong traction and abduction of the foot by Dr. N. Warner Van Lengen, one good twist of the clamp accomplished the results seen in Fig. 17. By further study of the original radiograph (Fig. 16) it is seen that in the uncorrected position of the bones, the line of support falls entirely within the astragalus. It is quite evident that this dear old lady could never have walked again, on such an ankle, without the support of crutches. As the case eventuated, she was walking unsupported at the end of four weeks, and now I am told has no soreness and no limp. Life has some satisfaction — for even a bonesetter.

No accident in the use of this technique has occurred yet in the writer's experience. Like every other therapeutic agent powerful enough to be capable of good, however, this clamp, if used with brutal disregard of the anatomical proprieties, is doubtless capable of harm. Used judiciously it seems to offer a means of attaining results impossible without it.

SURGICAL TREATMENT OF ACUTE GONORRHŒAL TUBE INFECTIONS WITH A QUARANTINE PACK[1]

By ROBERT C. COFFEY, M.D., F.A.C.S., Portland, Oregon

As an interne in the Louisville Hospital in 1895 and 1896, I noticed that more than half the number of patients in the female surgical ward were there for gonorrhœal tubal infections. A considerable percentage of them were in the acute stage, and all were treated by immediate operation with a mortality of more than 30 per cent, although a drainage tube was used. One surgeon, however, did the very radical operation of total vaginal hysterectomy for pus tubes, with very low mortality compared to the others; so when I left the hospital and engaged in the private practice of surgery, I followed the operator who had had the smallest death rate, and my first fifteen operations for pus tubes had but one fatality. About fourteen years ago my attention was called to Price's cofferdam gauze drain, by which it was unnecessary to sacrifice the uterus. This pack of gauze practically removed the mortality of these cases. The drains were removed about the fourth or fifth day and the wound repacked. As a result, from 25 to 50 per cent of the patients developed herniæ afterward. About ten years ago I began to protect the cofferdam drain with a sheet of rubber tissue placed above the gauze, thus preventing the intestines from coming in contact with the gauze. This was a decided improvement but I still removed the drains too early, including the rubber, and still continued to have a considerable number of cases of post-operative herniæ. Gradually I learned that the longer the drains were left (and particularly if the wound was not repacked afterward), the less likely the patient was to have a hernia, until finally by evolution we worked out the plan we now have which will be described later, and which is practically without post-operative hernia.

By far the most striking feature that we have noted in opening these abdomens for other conditions later, is the absence of post-operative adhesions. In a paper before the American Medical Association two years ago, I called attention to the use of the protected quarantine pack for the treatment of abdominal adhesions, which is the only way I have ever been able to completely cure persistent abdominal adhesions in a certain class of cases which we may call adhesion formers. We have used this drain for the purpose of quarantining a septic uterus following abortions, and even in puerperal sepsis as well as in all other forms of tubal infections. In tubal infections following pus infections of the uterus we have not for some time removed the tubes in young women, but have slit the tubes and used the quarantine pack in most cases. These cases heal up without a sinus. On the contrary, gonorrhœal pus tubes treated in the same way, after the ends of the tubes have been sealed, have resulted in sinuses, necessitating the removal of the tubes later. Every doctor who has treated gonorrhœa to any extent, when it involved any mucous membrane, has come to realize the seriousness and far-reaching effect of this infection. I believe it is an established principle that practically the only hope we have of curing gonorrhœa is by early free drainage; for instance, gonorrhœa in the female is treated far better by packing the vagina with dry gauze once a day and removing it, than by any amount of strong applications and douches. In rare instances it is probably true that gonorrhœal tubes which have been filled with pus and in which both ends have been sealed up, have reopened so that conception could take place. These instances are exceedingly rare. In some cases a single tube will become infected with gonorrhœa and the other will remain clear. These cases are relatively rare. In some cases a tube which has become sealed at both ends will become clear of pus, and will have its cavity open in the middle but there will be permanent closure of the fimbriated end. Several years ago I reported a method by which several of such tubes had been opened and the mucous membrane everted with the hope of making conception possible, but as far as I could learn conception never took place. However, there are undisputed cases in which conception has taken place after gonorrhœal infection, but where there is one such case, there are hundreds of cases which have been allowed to run on to a chronic condition in which the ovaries were infected and destroyed and the uterus permanently involved, tubo-intestinal or vesical sinuses formed, and the patients subjected thereby to years of unnecessary invalidism and danger.

There is a well-established rule among gynecologists never to tamper with an acute gonorrhœal salpingitis or pus tubes, but in the face of this my practice has been to the contrary for

[1] Read before the Seventh Pan American Medical Congress held at San Francisco, June 17, 1915.

Fig. 1. Intestines are held back with a gauze pack and retractors while gauze wicks are being placed side by side across the pelvis.

Fig. 2. Gutta-percha sheets of four thicknesses placed carefully above the gauze to prevent contact of gauze with intestines.

more than fourteen years. I have during this time not turned aside or postponed a single case of gonorrhœal pus tubes of an acute violent infection because of its acuteness, and in more than two hundred pus-tube cases treated in this way approximately fifty have been operated on in a very acute stage, during the past eight years without mortality. As much against well-known statistics as it may seem I have no more fear, as far as life is concerned, of opening and quarantining the pelvic organs in acute gonorrhœal conditions than of opening and removing an interval appendix or quiescent pus tube, provided the quarantine is extensive enough and is properly placed and discreetly removed. On the other hand the use of a drainage tube or small drain of any kind does not do the same work and is followed by a large mortality in such cases.

As has been previously stated a splitting of the gonorrhœal pus tube which has been sealed at both ends and has been treated by drainage as we treat other forms of infection, contrary to the results obtained in pus infections, usually leaves a discharging pus sinus leading to the tube, later requiring operation for its removal. The same is true in a certain number of cases in which gonorrhœal tubes have been tied off instead of excised. In other cases an abscess will form later at the cornu of the uterus. In three cases to which I have been called, the acute stage of known gonorrhœal infection was so early that the ends of the tubes had not sealed up. The pus could be seen on the fimbriated extremity and could be squeezed from the lumen of the tube. All three cases were in very young women and it was desirable not to unsex them, so in these cases we used the quarantine pack without removing the tubes or any other organ. Immediately the inflammatory process subsided, the fever receded, and all three cases have apparently remained permanently well as a result of the pack and free drainage. Two of the three were operated upon more than two years ago. In other cases where we have removed one tube for gonorrhœal infection and found the other infected but not closed, we have used the quarantine pack in the same way, and we have not been called upon to treat or reoperate upon any of these cases. It is true we have no report of such a case in which pregnancy has taken place afterward, but I feel hopeful some of them may later become pregnant. I am very hopeful that this timely drainage prevents closure of the tubes and helps to cure the gonorrhœa.

In the majority of cases, however, my practice being that of general surgeon and doing but little office treatment and no family visiting, the cases have usually been brought to me in a very active stage with a temperature running from 102° to 105°, with a rapid pulse and usually a peritonitis with distention of the abdomen. We have without exception opened such cases, and if the tubes are permanently sealed and have enclosed pus cavities within the tube, we remove the tube by excision at the cornu and place the quarantine pack. This operation in these extreme cases, of course, removes the least chance of pregnancy, but I believe that in cases advanced to this stage

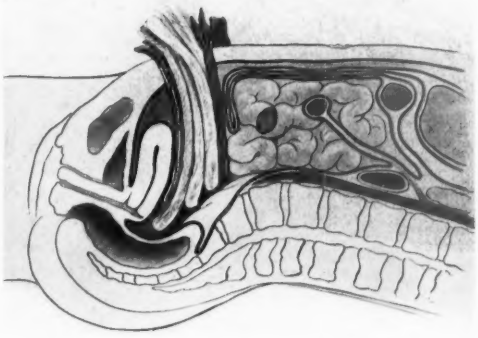

Fig. 3. Sectional view of the quarantine pack with application of gutta-percha above and below the gauze. (The gutta-percha between the uterus and gauze is by no means essential and is not desirable except where the primary object of the pack is to cure adhesions.)

the chance is only one in many hundred that they will ever become pregnant anyway, and by doing the operation at this stage the patient's suffering is cut off at once, the ovaries are saved in good condition, the possibility of serious adhesions with perforation into the bowel is completely removed, and the patient is cured and the likelihood of permanent incurable discharge from the uterus is very much lessened.

TECHNIQUE

The quarantine pack is placed as follows:

On opening the abdomen the fluid and spilled pus is sponged out with dry gauze. The intestines are packed entirely out of the pelvis. The entire pelvis is exposed to direct view by the use of malleable retractors. A large incision is used so that the work can all be seen. If the tubes are firmly sealed they are removed by excision down to the uterine mucosa with any infected portion of the ovary, leaving the healthy portion to be healed as a result of the drainage. The retractors are held in place and gauze wicks the size of a finger (not folded like the folds of a fan) are laid straight side by side entirely across the abdomen, putting sometimes twenty or thirty of these wicks, reaching to the bottom of the pelvis and gradually extending up the side of the pelvis, making a solid wall of gauze. After these wicks have been placed carefully a sheet of gutta-percha tissue of four or six layers is placed above the gauze, care being taken that the tissue goes entirely across the lower part of the cavity, absolutely shutting off all possibility of contact of the intestines with the gauze drainage. If the tubes

Fig. 4. Incision closed with pack protruding through lower end.

are not sealed, the quarantine is placed without removing them. The open ends of the tubes are left in contact with the gauze. The wicks and the rubber tissue in certain cases are then turned toward the patient's face, exposing the uterus and bladder, and another folded sheet of six or eight layers of gutta-percha tissue is carefully inserted between the gauze and the fundus of the uterus, this practically surrounding the gauze and making a completely protected pad. This second gutta-percha sheet should not prevent the open tubes from coming in contact with the gauze. In just one day less than a week or six full days after the pack is placed, the wicks are withdrawn leaving, the rubber tissue. On the fourteenth day the rubber tissue is removed, and according to the case we either insert a small rubber tube which is tapered at the point, or leave drainage out entirely. It usually takes such wounds about five weeks to heal. For four weeks we keep the patient in bed, preferably on the back most of the time.

During the past three years we have had practically no hernia following such operations.

CONCLUSIONS

1. Free drainage is the most important thing in the treatment of gonorrhœa.

2. It is quite possible that a much larger percentage of tubes infected with gonorrhœa may be saved and restored to normal function if seen early and treated surgically with a large protected quarantine pack, which at once gives free drainage and prevents the peritoneal surfaces from surrounding and sealing up the tubes during the first active inflammation, than can be done by the so-called but misnamed conservative treatment.

3. The quarantine pack used after removal of gonorrhoeal pus tubes makes the operation just as safe in the acute stage as during the interval, and saves the patients much suffering and many complications such as destruction of the ovaries, connecting the abscess with the rectum or bladder, and the formation of troublesome adhesions, as well as minimizing the chances of a chronic incurable discharge from the uterus.

IMMEDIATE PERINEORRHAPHY [1]

By ALFRED BAKER SPALDING, M.D., San Francisco
From the Woman's Clinic, Stanford University Medical School

IN practically every confinement at term, the pelvic floor of the primipara and of those multipara who have been successfully repaired following their previous confinements is damaged to some extent. The only patients who escape this damage are the ones who give birth to babies with very compressable heads or who possess an excess of elastic tissue in the fibrous sheaths of the pelvic floor. It is the duty of the obstetrician to attempt to limit this damage if he can, but the delusion held by many that it is possible to prevent pelvic floor laceration has added more misery to the patient than credit to the accoucheur.

Unless the condition has been repaired, either immediately after labor or later, or unless the tissues have become atrophic, it is a common experience in clinic work to find on examination multipara with more or less relaxation of the pelvic floor. Moreover, many patients who have been repaired present themselves with various degrees of pelvic floor relaxations.

Baker Brown, half a century ago, taught the profession to sew the labia together in cases of pelvic outlet relaxation and undoubtedly thousands of women were so ridiculously maltreated. A little later, Thomas Emmet contributed to the ill health of women by teaching the profession the wonderfully clever, very technical, undoubtedly efficient secondary perineorrhaphy that bears his name and even such distinguished obstetricians as Hegar and Sänger aided and abetted Emmet in this unintentional error by directing attention to the cure rather than to the prevention of rectocele. Lawson Tait, that genius to whom the profession can never pay proper tribute, completed the conspiracy against healthy motherhood by giving to the profession his classical flap-splitting perineorrhaphy. He wrote, in 1879: "The day has gone when the treatment of pelvic and abdominal diseases so prevalent among women and so rare among men is regarded as the mere appendix of the work of the accoucheur," and in the same book said, "Laceration of the perineum to some extent is the almost inevitable result of the first labor but unless painful fissure or a tender cicatrix be left from imperfect recovery, it requires no treatment." Finally he said, "there

Fig. 1. Laceration of the pelvic floor involving both sulci of the vagina, and separating the levator ani muscles.

[1] Read before the Nevada State Medical Association, June 17, 1915.

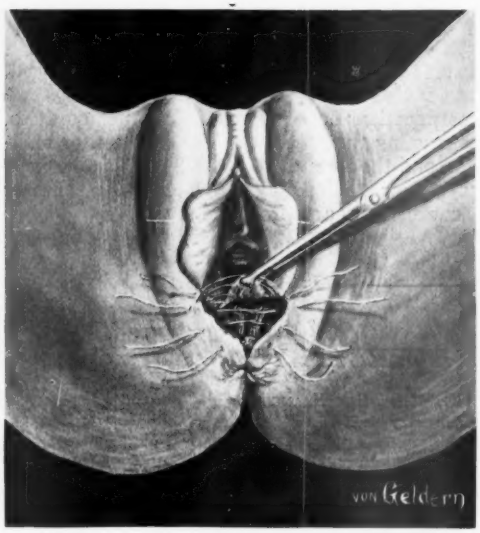

Fig. 2. Top stitches are of chromic catgut. One continuous suture to close each sulcus laceration. Lower stitches are of silkworm gut. Deep part of figure-of-eight through separated levator ani muscles. Superficial part of suture through superficial muscles, fascia, and skin.

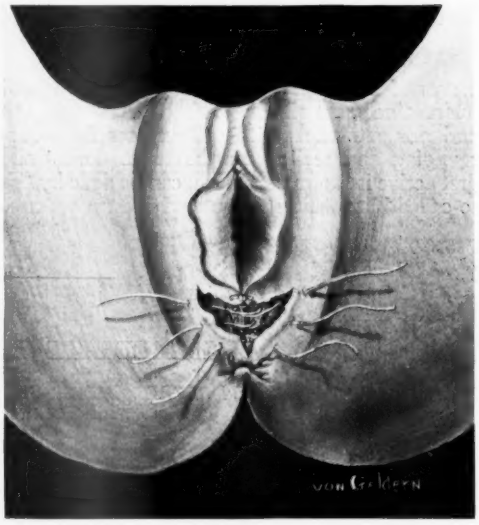

Fig. 3. The ends of the chromic gut sutures are tied together, repairing the lacerated vagina.

are only two conditions which require surgical repair — rectovaginocele and vesicovaginocele."

The sequellæ to pelvic floor relaxation such as constipation, bladder irritability, backache, cervical hypertrophy, retroversion, subinvolution, prolapse, and neurasthenia are too well

Fig. 4. The figure-of-eight sutures are tied, bringing together the levator ani muscles and the superficial structures of the pelvic floor.

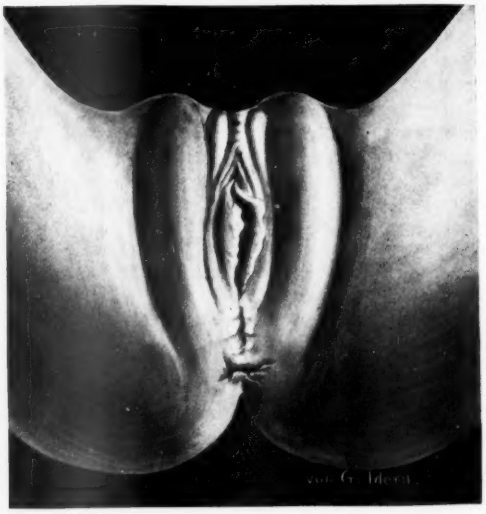

Fig. 5. Ten days post-partum. The vulva is closed. The vaginal walls lie against one another, and the levator ani muscles can be palpated in normal position.

known to need discussion. The cure of these conditions occupies the attention of a large number of surgeons. There are always in the hospital many patients recovering from operations performed for the relief of these symptoms.

The time to cure prolapse is not when the uterus has prolapsed but when the woman begins her first pregnancy. Many important procedures should be considered weeks before labor starts and prophylaxis carried on, not only during the time of actual labor, but also during the period of involution which follows labor. When labor ends it is wise to agree with Tait and remember that "laceration of the perineum is the almost inevitable result of the first labor."

Proper inspection will usually result in giving more than sufficient evidence of the damage present. As to when the repair should take place, it makes little difference whether the operation is performed at once or a few days later provided operation is done before cicatrization has occurred. Complete anæsthesia immediately postpartum is best although the operation can be performed on some patients without anæsthesia. Partial anæsthesia given by an incompetent is distinctly bad. At least one good assistant is an essential to good work. The same instruments are needed as are used in the denuding operation and far more careful asepsis must be carried out. For thirteen years I have tried a number of different operative procedures to restore the damaged pelvic floor immediately after labor and have met with varying degrees of success until gradually I have perfected a comparatively simple and very efficient perineorrhaphy, the performance of which has become routine with me and with my clinical assistants.

The first step in this operation, after packing the vagina, is to locate the levator ani muscles. It frequently happens that these muscles have retracted a distance of three to four inches and unless care is taken the deep transversus perinei muscles will be sutured by mistake. The muscles are brought together with three or four silkworm-gut sutures. The second step consists in repairing separately each laceration in the vaginal sulci, which at times extend to the cervix, with a continuous light chromic gut suture, tying these two sutures finally so as to restore the base of the vulval canal. It frequently is seen, after tying these sutures, that the perineal laceration lies obliquely or almost transversely to the median raphé. The third step of the operation consists in crossing the silkworm-gut sutures through the opposite superficial muscles and fascia so as to approximate the skin laceration and to tie these sutures not too tightly.

The accompanying descriptive plates explain the steps of this operation, the principles of which have been taken from accepted surgical practice.

Since performing this operation first in 1907, several papers have appeared in the literature describing operations similar to this principle although differing in technique, so no claim is made for originality. The reason for presenting the subject of immediate perineorrhaphy is not for such purpose but to call attention to the fact that the treatment of procedentia is not so difficult if prophylaxis is begun with the first confinement, which nearly always is associated with pelvic floor laceration, and if the separated levator ani muscles are repaired by an immediate perineorrhaphy.

RETRODISPLACEMENTS OF THE UTERUS[1]

By J. CRAIG NEEL, M.D., San Francisco

THE operative treatment of retrodisplacements of the uterus has been the subject of much study in every gynecological clinic for many years. The fertility of the surgical imagination is well illustrated by the publication of over fifty different operations for their correction. While many of these operations have yielded excellent results, especially when performed according to the original technique, insufficient attention has been given the individual features of the different cases and failures have resulted from the effort to adapt one procedure to all conditions.

A diversity of opinion has existed as to what really constitutes the normal support of the uterus. The mechanism is a complex one and there are many forces working in conjunction to poise the uterus and to maintain adjustable relations without interference in performance of the various functions of the surrounding struc-

[1] From the Gynecological Clinic of the Johns Hopkins Hospital.

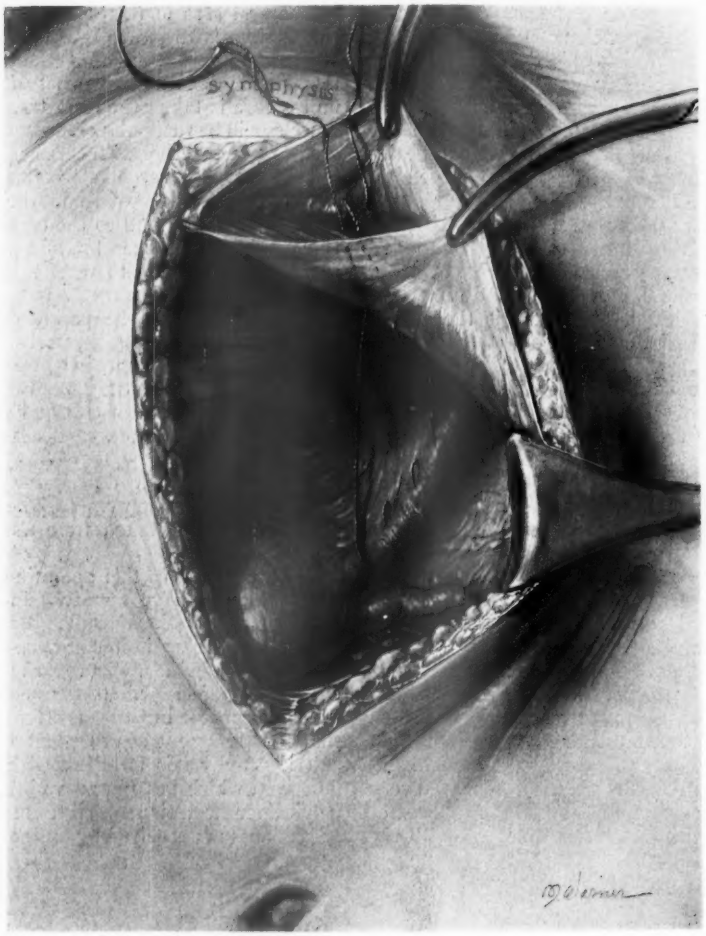

Fig. 1. Shows one silk suture introduced through the undersurface of the rectus fascia; brought through the abdominal wall and carried along the parietal peritoneum to the internal inguinal ring and then taking up the anterior wall of the broad ligament and piercing the round ligament. It is then brought directly out through the abdominal wall.

tures. The supporting tissues may be divided into intrapelvic and perineal structures. Under the first division are the broad, round, uterovesical, and uterosacral ligaments. The effect of the broad ligaments is readily demonstrated in cases requiring their severance from the uterus, when the fundus drops backward and finally becomes completely prolapsed on the rectum unless some additional support is utilized. The round ligaments play an insignificant part as a constant support of the uterus while their real function is shown by the marked hypertrophy during pregnancy. When the abdomen is opened with the uterus in normal position, the round ligaments are never found on tension and in many cases leave the abdomen at a point posterior to the axis of the fundus of the uterus. Nevertheless the round ligaments are the points of attack in practically all operations for retrodisplacements while the more important structures have re-

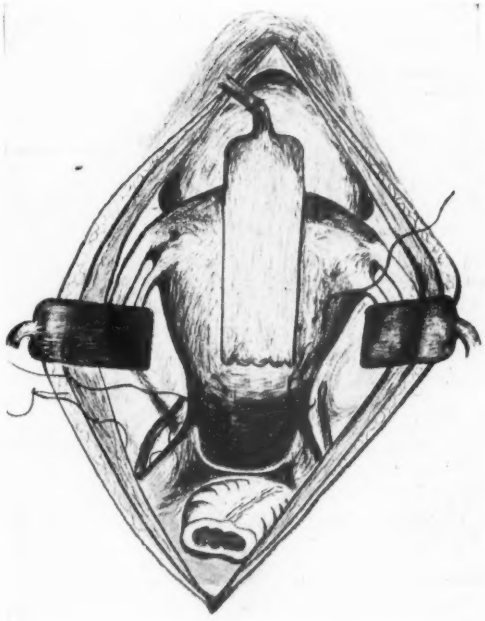

Fig. 2. Shows the course of the sutures taken in the uterosacral ligaments. The ureter is indicated on either side, just lateral to the ligament.

Fig. 3. Shows sutures tied and the operation completed. Attention is especially called to the pocket made by shortening the uterosacral ligaments for the support of the tube and ovary.

ceived very little attention. The uterovesical attachment permits of wide excursions and in itself probably contributes very little actual support. This brings us to a consideration of the uterosacral ligaments.

Backward displacements of the uterus are divided into two main divisions: (a) retroflexion, in which the normal position of the cervix is maintained while the fundus is bent backward into the cul-de-sac of Douglas; (b) retroposition, in which the normal relation of the fundus and cervix persists while there is a loss of tone in the supporting structures allowing the entire uterus to be displaced to the pelvic floor. The cervix is normally more rigidly held in the pelvis than the fundus and its anteroposterior position depends almost entirely upon the tonicity of the uterosacral ligaments. In operations so far described, but little attention has been given to the position of the cervix and its restoration to a normal position. In true retrodisplacements, as we have recently demonstrated in a number of cases, a shortening of the uteroscaral ligaments not only brings the cervix into its normal position but also suspends the fundus in an excellent manner.

Uncomplicated retrodisplacements rarely cause symptoms. Hence the effect upon the function of the surrounding structures is the important factor to be overcome in all operative procedures. Therefore the ideal operation cannot be one that merely swings the fundus into position without any regard to the surrounding structures, and unless the normal relations of the pelvic viscera are restored many failures will continue to be recorded.

The restoration of torn perineal structures acts chiefly in the support of the cervix and thus prevents the prolapse of the pelvic viscera.

The following operation suggested by Dr. Kelly and modified by me has been performed in something over one hundred cases and the results have been most satisfactory:

Through a midline incision the pelvic viscera are exposed in the usual manner and the fundus brought forward to its normal position. The fascia of the rectus muscle is then dissected free just above the symphysis pubes to allow the permanent silk suture to be anchored to the undersurface about four centimeters from the midline

incision. This suture is then carried through the underlying rectus muscle and peritoneum immediately above the vesical reflection on the abdominal wall; the parietal peritoneum is next taken up at about one centimeter intervals down to the internal inguinal ring; the suture is then carried along the course of the round ligament to a point within one or two centimeters of the uterine cornu where the ligament is pierced and the suture is brought out through the abdominal wall near the point where it entered (Fig. 1). The same procedure is followed on the opposite side. Both sutures are then drawn tightly and tied, the knots being buried under the rectus fascia. The results obtained by the introduction of these sutures are: (a) The broad and round ligaments are utilized and given a broad attachment to the abdominal wall. (b) The lateral openings are closed by the purse-string action of the suture and thus prevent the incarceration of the bowel. (c) The fundus is loosely poised in the pelvis with the slightest possible mutilation.

In order to bring the cervix into its proper position a running purse-string suture of silk is taken in the cervix where it is joined by the uterosacral ligament on either side and carried along the course of the ligament to the pelvic brim (Fig. 2). In placing these sutures the ureter which usually lies outside the ligament must be avoided. When these sutures are tied, the cervix is drawn high in the vaginal vault and a shelf is made on either side for the support of the tube and ovary (Fig. 3).

The excellent results so far obtained from this operation lead us to believe it to be the most nearly ideal operation for retrodisplacement so far described. Its advantages are:

1. There is no mutilation of pelvic structures.
2. It leaves no injured surface to favor adhesions.
3. The normal supports of the uterus are utilized in such a manner as not to interfere with their evolution and involution and therefore it offers no hindrance to future gestation.

DUODENAL FEEDING[1]

By CLEMENT R. JONES, M.D., Pittsburgh

Professor of General Pathology, Materia Medica, and Therapeutics, Dental Department, University of Pittsburgh; Consulting Gastro-Enterologist Mercy Hospital; Consulting Physician, Diseases of the Stomach, Presbyterian Hospital.

ORIGIN

THE duodenal tube as used by Dr. Einhorn has been of exceptional service in selected cases from the time when it was first called to the attention of this society. From the first it impressed me as the ideal method of obtaining rest for the stomach, and at the same time supplying the body with nutritious foods at a point in the intestinal tract where it can be digested. Long before its introduction, I had given up the idea of trying to supply nourishment to the body through the colon, with the exception of water in normal saline solution per rectum.

Certain points in the modification of the treatment, suggested by Dr. Morgan, have served to place the treatment on a very practical basis: (1) the longer tube which allows the food to enter the intestines at a point where it can exert no direct pressure on a duodenal ulcer; (2) the discontinuation of the use of sugar of milk in some cases; (3) the drop-by-drop method, by which it is possible to keep up a continuous flow of the nutrient fluid. In addition various slight changes in the technique must be made from time to time by those prescribing this treatment.

USES

The early cases in which it was of service were gastric and duodenal ulcer in which the methods formerly in use had not been satisfactory. It was also found satisfactory in recurring cases where it was thought advisable to vary the treatment from former rest cure methods, and in cases of long standing, and of the severer type. In one of the first cases which I treated by this method, there occurred a perforation followed by fatal peritonitis. This was the only case of the kind which had occurred in a series of about two hundred cases in my service at Mercy and other hospitals, and it would have been more discouraging to me had it not been followed by a second case of perforation in a patient for whom I considered duodenal feeding, but decided to use another method. This second case was one in which the pain following perforation was very acute and was promptly reported to me. The patient was operated upon within three hours and made an uneventful recovery.

These were both cases of duodenal ulcer. In the first series of cases a much shorter tube was used than is now employed. Since using a tube

[1] Read before the American Gastro-Enterological Society, Baltimore, May 10-11 1915.

of a length which will allow about fifteen inches of tube for the duodenum, the comfort of the patient has been increased, the possible danger of perforation from pressure has been removed, and the results have been more generally satisfactory.

In a number of cases of ulcer I have used along with the tube, feeding a daily dose of scarlet red in capsule given by mouth along the side of the tube with apparently good results. The nature of the treatment, however, is such that a considerable number of cases would be necessary to show that any definite advantage was obtainable by its use. The results reported from the use of scarlet red by Doctors Friedenwald and Leitz I believe justify its trial in selected cases, especially of the recurrent type or those which have failed to respond to other forms of treatment.

The use of this method of feeding in cases other than ulcer, has broadened the field of application. I refer to cases of ptosis, atony, and dilatation of the stomach. In this use of the treatment I have in some instances been successful in relieving these conditions when other methods have failed. One of the most interesting of these cases I here report. These patients are either normally very thin or are well below their normal weight and tone and present a syndrome sometimes difficult to differentiate from ulcer.

Since the earliest study of atonic gastric diseases many forms of treatment have aimed at giving rest to the stomach, but until the duodenal tube was suggested nothing more than partial rest was attainable. By duodenal feeding we are able to keep up the nourishment to an amount sufficient to maintain the body weight or increase it and at the same time rest the organ, giving time for recuperation of the atonic or ptosed stomach. In some cases the same food introduced through the tube into the duodenum could not be taken care of when taken into the stomach; in fact it was so changed by long retention in the stomach that it had become unfit for intestinal digestion. In the case of Miss M. there seemed to be at all times a residual content in the stomach which prevented the food passing into the duodenum, without contamination.

After feeding is begun through the tube, there is perfect comfort on the same liquid foods which cause distress both gastric and intestinal when taken by mouth. In such cases we have the problem before us of so increasing the efficiency of digestion by rest and forced feeding as to increase the weight and tone to a point where the fat and tonicity approach normal. When the patient has regained his normal weight and has maintained that weight for a sufficient length of time, say one year, it may be safe to return to a not too confining vocation.

The period of the treatment of atony, dilatation, and ptosis during which duodenal feeding is being used is only the beginning of the treatment when time is considered, but as a good start it is half the race and a good foundation necessary to a permanent structure. So this rest of body and stomach which also admits of forced feeding gives momentum to the launching of these therapeutic measures and permanence to the results. If the dietary and hygienic regimen which should continue for varying long periods after the duodenal feeding has been discontinued is observed by the patient, an increased number of these patients should regain their normal health. Improvement in the general tone and catabolic functions of the body being the object of medical management of all cases of this kind, such temporary means as will bring about a rapid reconstruction cannot, I believe, fail to become more and more popular as a part of the treatment of atony, dilatation, and ptosis.

DIFFICULTIES

In cases of extreme ptosis and hypomobility it is sometimes a number of days before the tube will pass through the pylorus. However, persistence will usually be rewarded by success. If it takes longer than twelve hours for the tube to pass the pylorus, I order the patient fed as usual as though the tube had not been introduced. In a recent case the ptosis was so extreme that the tube failed to pass after more than two weeks.

In one case I had great difficulty in withdrawing the tube which was introduced in a very normal way, but when my assistant attempted to remove it three weeks later, it was firmly held by the œsophagus, about 25 cm. from the teeth, where it remained until the following day at which time I removed it by very strong traction while the patient stood behind a fluoroscopic screen where we could observe the progress upward of the metal ball. The ball was so firmly held that I was not willing to make sufficient traction on the tube to remove it prior to using the fluoroscope, by means of which I could watch the effect on the ball, and see that it was gradually moving upward. The contraction about the ball extended for several inches along the œsophagus, and was, I believe, spasmodic as the patient was of a very nervous type. It occurred to me afterward that an antispasmodic or atropin might have been used in this case with good results.

METHOD

The method of feeding used in my work is substantially as follows:

We begin by introducing the tube with much the same technique as we use in introducing the gastric electrode. The patient swallows the tube taking a swallow of water and we gradually feed the tube in as fast as the metal olive is carried down. The patient is placed on his right side and instructed to retain that position until such time as we are able to demonstrate the presence of the tube in the duodenum. When we succeed in passing the olive into the duodenum which takes from twelve hours to seven days and which is ascertained by the withdrawal of intestinal contents from the tube by means of the glass syringe provided for that purpose, we at once begin the feeding. A half grain of codine sulphate is given an hour before the tube is introduced. If the patient has an unusually sensitive throat, I use a method of cocainizing the throat and œsophagus which I have used for a number of years where there was any difficulty in introducing the stomach tube. I dissolve one-fourth grain cocain hydrochloride in one dram of water, have the patient gargle with it and then swallow the solution. This effectively cocainizes the throat and œsophagus, and the tube, whether stomach or duodenal, is introduced without discomfort.

The feeding is begun first with two ounces of sweet milk every two hours, the milk being heated to 104° when placed in the container. We use one of the graduated containers now in such common use in administering salvarsan intravenously. The tube and cut-off extending from the container to the duodenal tube are the same as those used in the giving of continuous salines, and the rate of feeding is from 60 to 120 drops per minute. On the second day we increase to four ounces and so on increasing two ounces each day up to twelve ounces every two hours, from 8 a.m. to 8 p.m. Then we add the white of an egg to every second feeding, next the whole egg to every other feeding, then a whole egg to every feeding. If there is no excessive putrefaction evidenced by the fæces, or distention by gas, we continue to increase the food, giving first a milk of 6 per cent butter fat, then increasing to 8 and 10 per cent butter fat, and finally increasing the eggs to twelve to fourteen eggs per day, and the 10 per cent milk to 120 to 128 ounces in 24 hours. In most instances the food in such quantities is well borne even in cases which do not increase in weight under the treatment. In preparing the food the most important step in the technique is the straining through three or four thicknesses of fine linen after the final heating so as to remove any clot of milk or eggs which might obstruct the tube.

In a patient recently treated, milk did not agree and was found in the fæces in large curds, there was constipation, distention with gas and discomfort, and the patient did not sleep well. Two ounces of milk were modified by diluting one-half with water and adding citrate of soda one grain to the ounce; also the white of an egg. After feeding successfully for several days the milk was increased to six ounces, the water to six ounces, with one whole egg every two hours. Constipation cleared up on a total dosage of 63 grains daily of citrate of soda.

The service of a carefully trained nurse for this work is necessary. When one has a nurse who has had experience in a number of these cases, the work will not so frequently demand extra attention on the part of the physician.

The capacity of the duodenum seems to vary almost as much as that of the stomach: one patient will complain of slight discomfort if the feeding proceeds faster than usual; another will experience no discomfort with comparatively rapid feeding. However, as the patients whose duodenums have small capacity become more accustomed to the feeding they are able to take the full ordinary feeding of twelve ounces without distress of any kind.

In the treatment of ulcer I have seldom fed more than 84 ounces of milk and six eggs per day, and only in those cases under weight in which an increase in weight is desirable have I carried the feeding to the extent above mentioned.

CASE 1. In May, 1911, Miss M. a nurse, complained of pain after meals; loss of weight; eructation of gas. Stomach contents showed no free hydrochloric acid, total acidity 20; no blood in fæces or stomach contents. Rest in bed was advised, and liquid diet. The patient improved and as she was in training in the hospital, after-treatment was such as could be given and work continued. The patient was fairly comfortable until April 1, 1914, when she again consulted me giving a history of the return of gastric distress, pain soon after meals and continuing for some hours. Weight 116¼ pounds, former weight 158, is 26 years old. Stomach contents shows no free hydrochloric acid, total acidity 20, a trace of bile. Blood: hæmoglobin 90, red cells 4,250,000, leucocytes 6,000. Fæces: occult blood, negative.

Röntgen examination shows stomach apparently devoid of tone, duodenal feeding advised, and tube introduced. The tube entered the duodenum on the seventh day. Feeding was begun with 2 ounces every two hours increased 2 ounces per hour per day up to 12 ounces. On the sixth day added one egg t. i. d. then one egg every four hours. All symptoms were relieved on discontinuance of food by stomach. The patient improved rapidly, and was sent home at end of 5 weeks, having gained 10 pounds.

On May 25, 1914, the patient returned with the same symptoms. The pain is more severe and she thinks she must have something more serious than we are able to find by X-ray or other diagnostic methods. She suggests an exploration, as a neighbor with similar pain had been operated on and an ulcer found.

Condition before operation. General condition fair. Has some pain over cæcum. Pain not marked, but is present more or less all the time. Red blood cells, 5,800,000; white blood cells, 6,000. Operated on June 3, 1914.

Macroscopic. Appendix about five inches long, hard, undergoing obliteration. No adhesions. Meso-appendix perfectly free. Abdominal contents examined. Stomach and duodenum normal to touch. Stomach slightly ptosed.

Transverse colon found in pelvis, could be lifted out at least ten inches from incision. Cæcum slightly mobile. No Lane's kink or Jackson's membrane. Gall-bladder and pancreas normal. No pathological condition found, save ptosis. Large bowel contained much hardened fæcal matter. Uterine organs normal. Both kidneys displaced.

Duodenal feeding was begun again on June 20, and continued six weeks. Weight on July 1, 1914, 110 pounds; on July 29, 135½ pounds — a gain of 25 pounds in four weeks. The smallest amount of food given in any one day during the last four weeks was 96 ounces milk and six eggs; largest amount taken in 24 hours, 128 ounces of milk, 10 per cent butter fat, and 14 eggs. During this period no symptoms of gastric or intestinal character were in evidence, the abdomen was soft, no laxative was necessary and there was no diarrhœa. The patient frequently remarked if she could only hope to be as comfortable after the tube was removed as during the treatment she would be well satisfied.

History since leaving hospital. Had some gastric symptoms of a mild character during the first few weeks after leaving hospital which gradually disappeared. In a letter dated Columbus, Ohio, April 23, 1915, patient stated: "I am in excellent condition physically, my weight has increased from 110 to 153 pounds; my stomach has not caused me even the slightest discomfort during the last four or five months."

Case 2. A hotel clerk entered the hospital November 1, 1914, having had an attack of severe hæmatemesis. He gave the following history: In 1909 had a rest cure of the von Leube type for gastric ulcer. At that time he gave a history of a previous partial rest treatment. Treatment by von Leube method with subsequent restricted solid diet, gave relief of all symptoms until August, 1910, when he had an acute attack of appendicitis, was advised by a surgeon that his symptoms in previous history were all due to appendicitis, and that restricted diet was unnecessary. After a short period symptoms of ulcer returned and continued with more or less severity until his profuse hæmatemesis occurred on the day of his admission to hospital November 1, 1914. He gave an account of having been papering a bath room in his apartments the evening before and his wife noticed his pale condition at breakfast. He felt somewhat nauseated at times during the day and at 6 p.m., vomited a large quantity of dark clotted blood. He was sent to Mercy Hospital and his symptoms at 7 p.m. were extreme pallor, slight nausea, pulse 100, respiration 24, temperature 99°. Ordered ice to epigastrium, morphine ⅙ gr. hypodermically; adrenalin 1:1,000 in thin gelatine ¼ ounce every third hour. November 2, 1914: Normal salt solution 6 ounces per rectum every fourth hour; ice by mouth in small quantities. November 5, 1914: Albumin water every third hour. November 7: Milk 2 ounces every third hour. November 8: Duodenal tube introduced, feeding continued until December 12, 1914.

Examination of fæces on November 14, 1914 was negative for occult blood (benzidin test); also November 16, 18, 20, 23, 27 and December 2.

December 19, 1914, discharged from hospital.

January, 1915, condition good.

Case 3. Married woman, age 28. History of ulcer, nine years ago, no symptoms during that time.

The patient was taken ill November 25, 1914. I was called in consultation December 11, by Dr. Everhart who asked me to take charge of patient. She was removed to Mercy Hospital, and for two weeks she has been on a liquid diet, has rested in bed and has had hot poultices on the epigastrium. There has been no improvement in the pain, which is severe. It comes on when the stomach is empty, she vomits small quantities of blood. These symptoms continued for two weeks. Blood was present in stools. Blood count: leucocytes 12,000; red cells 3,950,000; hæmoglobin 76, December 30, 1914. January 5, 1915, blood count: leucocytes 6,800; blood present in stools, December 22, 23, 31. January 4, 6, 12, 1915, negative. Blood present in emesis December 28, 1914. Urine normal.

The patient was put on duodenal feeding, the tube was in place in twelve hours. Pain was only partially relieved, but became gradually less and ceased entirely at the end of one week. Feeding was continued for four weeks. The patient returned to solid diet gradually, and she had no pain or distress of any kind up to leaving the hospital.

Condition February, 1915: no symptoms on restricted solid diet.

March 30, 1915, condition: well.

Case 4. March 19, 1914, Mrs. L., age 49, consulted me complaining of stomach trouble of fourteen years' standing. She has been treated in Carlsbad and Europe; has noticed that for a long time, stomach retains food until after the time of the next meal and frequently puts her finger down her throat to induce vomiting which gives her relief, bowels constipated and complains of acidity, analysis of stomach contents shows total acidity of 36; free hydrochloric acid, 20; very little mucus, very faint positive benzidin reaction; physical examination no points of tenderness in the region of the stomach; gall-bladder or appendix. Röntgen examination shows stomach atonic and ptosed, somewhat dilated. Entered hospital April 15, 1914, was given treatment by duodenal feeding for four weeks; examination of stomach contents June 15, 1914, showed total acidity 52, free hydrochloric 40, Röntgen examination by fluoroscope showed greatly improved gastric motility stomach in practically same position as before treatment. Patient can now take three meals of moderate quantity without distress. October 16, 1914, patient has continued well with quantity of food considerably increased with the exception of occasional slight distress from an exceptionally full dinner.

May 1, 1915, on inquiry as to present condition she reports that she is in better health than she has been for some years.

Weight normal at 140.

An interesting observation was made in a number of cases of ptosis treated by this method. We found on roentgenological examination when patients were symptomatically well that the stomach remained in practically the same position as when examined prior to treatment. I believe that the position of the stomach in these cases is relatively unimportant, the symptoms probably being due to lack of normal tone.

DISCUSSION

Dr. Julius Friedenwald, Baltimore: I have used the tube a great deal for the feeding of patients with ulcer not relieved by the usual method of feeding, and in cases of persistent vomiting. It is especially useful in cases of persistent vomiting not relieved by other methods. I am quite convinced that I have saved the lives of some patients by the use of the tube. One patient especially who had nearly succumbed to the vomiting began to pick up after the use of the tube, and I am sure that the treatment saved her life.

Dr. Franklin W. White, Boston: I should like to say just a word about the subject. It seems to me that this method is too much neglected. When I tried it last year in the Boston City Hospital, I found that that was the first time that it had ever been used there. It is valuable in selected cases, but not as a routine procedure. In a limited group, like these cases of atony or malnutrition, or persistent vomiting, I think that the results are quite brilliant at times. I have been impressed with the results in my own practice during the past year, even when the tube had to be sent out to the country with full directions to be used by a local doctor.

In severe cases of ulcer with vomiting, malnutrition, dry tissues and perhaps hæmorrhage, I have found this method valuable in preparing the patient for the operation.

Dr. Willy Meyer, New York City: It would not be fair to Dr. Einhorn not to corroborate the statements of Dr. White on the basis of my personal experience. I am using the tube more and more in my work, and find it a valuable therapeutic adjunct. My experience with it is limited to ulcer cases, in which I find it most valuable.

Dr. Seymour Basch, New York City: I would suggest that Dr. Einhorn be asked to say the last word.

Dr. Max Einhorn, New York City: Dr. Jones says that in one of his early cases he feared that the perforation might have been due to the use of the tube. In my large experience, and I have had a very extensive experience with this method, I have never had any perforation from its use. The tube is about one meter long, and I let it go in about eight centimeters from the teeth. I think that is far enough; but we can let it go in as far as ninety-two centimeters. In one case, I had to pull it out a little, because the patient could not stand having it deep in the small intestine.

Dr. Bloodgood: Will you please repeat the length?

Dr. Einhorn: The whole tube is usually one meter long, and we let it go in to about eighty, and sometimes to ninety centimeters. Usually, however, it is enough if it goes in to between seventy and eighty centimeters, because the pylorus is only fifty-six centimeters from the teeth. When the tube is allowed to go in eighty centimeters, it is twenty-four centimeters beyond the pylorus, which is quite a long distance.

Now there is one more point that I should like to speak of, and that is concerning the remarks about atony, dilatation, and ptosis made by Dr. Jones. He said that he had found good results from the treatment in these cases, but no change in the conformation of the stomach. I do not doubt that such cases may occur; but I have notes of cases in which I did find a change. In about half of the patients that I examine merely on account of this extreme atonically dilated stomach, I find that after two weeks without food in the stomach, there is a change in the shape of that organ; so that it extends only to the navel, instead of hanging lower. I do not think that this happens in each case, but it may occur.

Another statement to which I wish to refer is one made by Dr. Aaron, who said that he never finds a change in the anatomy of the condition. I do not substantiate that. We can see these cases and institute measures of building up the patient, and a year later find the ptosis gone. There is no ptosis or movable kidney after the building up of the system, and I am sure that there are clinicians here who will substantiate that statement from their own experience.

THE TECHNIQUE OF PYELOGRAPHY

By STANLEY R. WOODRUFF, M.D., Bayonne, New Jersey

TO bring pyelography down to a safe and sane basis we have endeavored to absorb the ideas of some of the pioneers in this work and use them in connection with our own experience. We have found the taking of skiagrams an absolutely safe procedure in every way if done with care and gentleness. These are the two watchwords of good pyelography — care and gentleness. With these always in mind there will be no deaths in this work.

Our technique as used at the Bayonne Hospital and Christ Hospital, Jersey City, is as follows:

The patient, with bowels prepared, is placed in the usual position for cystoscopy, on a table *directly under the X-ray tube.* This is the most important point in the whole procedure and to disregard this point causes great discomfort to the patient and possibly his death. The best arrangement is to have the cystoscopic room next to the X-ray room so that wires and a window may be cut through and a tube used at any time in the cystoscopic room. This arrangement makes it possible for the X-ray operator to go on doing his own work, and when the cystoscopist is ready with his patient the X-ray man can readily snap him. This allows each man to keep out of the way of the other, and facilitates matters greatly in a busy clinic. Where this arrangement is not feasible the X-ray room must be used.

We use collargol mostly in our work. We purchase it already prepared by the manufacturer, which is a far better procedure than to try making solutions, and it is always ready, thoroughly dissolved and sterile.

Our object in writing this paper is to emphasize the importance of insisting that all work on the patient be done under the X-ray tube. We believe that most of the injuries and deaths reported have been due to careless injecting and subsequent rough handling of the patient. We all know that the urinary bladder distended with fluid will probably not rupture unless subjected to some sudden jar. We are sure that the kidney pelvis when full of collargol will not rupture unless under the same circumstances. Therefore, after the collargol has been injected the patient should be kept absolutely quiet until all manipulation has been done and the fluid has drained away. We insist on the patient lying quietly on the table for a half hour after the picture has been taken to allow the kidney pelvis to empty itself. We do not leave the ureteral catheter in place unless a large amount of collargol has run in, showing a cavity, as we believe the ordinary ureteral peristalsis will empty the kidney pelvis much quicker than it will empty through the catheter. We also take care that the bladder is empty of cystoscopic fluid in order to obviate back pressure from that source.

We insist on there being no pain from the injection of the collargol. We consider our technique absolutely wrong if we have caused colic or distress. It is not necessary to distend the kidney pelvis or the cavity to be photographed at all, as the peculiar viscosity of collargol allows it to cover the inside of any cavity even when not filled by it. Eisendrath has clearly shown that overdistention and overpressure are the cause of all trouble after pyelography.

If we wish to measure the cavity to be injected we use a solution of methylene blue, running it in also by gravity and watching for its exit alongside the catheter in the ureter when the cavity is full.

As an apparatus we use the barrel of a good-size glass syringe, holding about 20 ccm. and graduated to show the amount of fluid we run in. A small rubber tube is connected with this and at the end is a small stop-cock. This apparatus can be put together by any one.

After the cystoscope is in place and the catheter inserted to the pelvis of the kidney a cystoscope holder should be used to hold the instrument in place and give the operator the use of both hands in the subsequent manipulation.

The operator sits in front of the patient in the usual position and connects the stop-cock to the ureteral catheter, which, by the way, should have a funnel-shaped extremity, the junction being wound with adhesive plaster to prevent leakage. If a funnel catheter cannot be procured a small rubber tube connector may be used. The stop-cock may now be turned and the collargol allowed to run in, the operator holding the receptacle in the left hand at such a height until he sees the top of the fluid recede. It can then be lowered to a point about a foot above the patient's body depending on his or her corpulency.

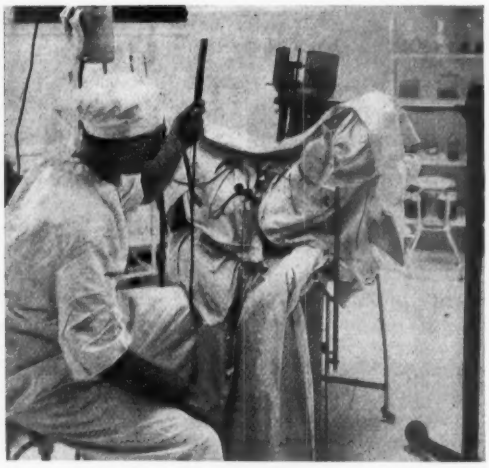

Fig. 1. Shows the proper position of the patient, X-ray tube, and operator, for pyelography.

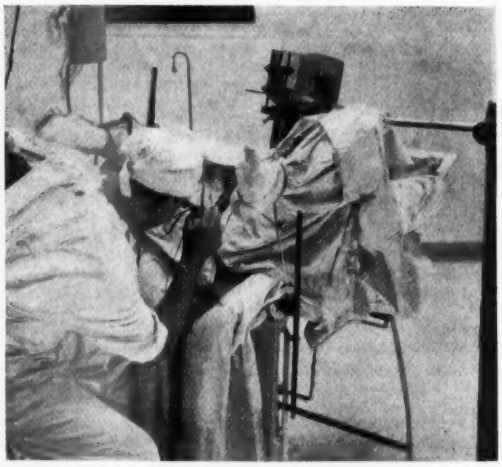

Fig. 2. Shows the operator looking into the cystoscope to detect any collargol coming out the ureteral opening.

We do not believe in using a fixed stand or point to which to attach our injection fluid. We think this should always be under the hand and eye of the operator to instantly answer any sign of distress by lowering the receptacle or raise it a trifle if the fluid does not run.

The operator should from time to time glance into the cystoscope and see if any collargol is coming down alongside the ureteral catheter. The presence of collargol should be a signal for lowering the pressure of the injecting fluid, which can readily be done by dropping the left hand a trifle. It is also a signal for taking the skiagram. If the patient must be shifted a trifle to get the X-ray plate under the back, the swivel-joint on the cystoscope holder must be loosened so as to allow movement of the instrument and not traumatize the bladder mucosa. The better plan is to have a frame with an X-ray pervious top made to be placed on the table, as advocated by Hugh Young, before the patient is laid there. This frame should be just high enough to enable the operator to slip an X-ray plate under the patient at any time, thereby doing away with any disturbance of the patient.

With the cystoscope held firmly in position, with one hand holding the injecting fluid and an eye on the ureteral mouth in the bladder, with the X-ray tube over the patient ready to snap the picture, we can conceive of no possible way of injuring a kidney.

This technique will do not only for collargol but for any X-ray positive substance as thorium citrate, recently advised by Burns of Baltimore.

We use this in 15 per cent solution, and have modified the authors technique by adding a small amount of methylene blue. The solution of thorium citrate is absolutely colorless, which we consider somewhat of a drawback. We like to be able to trace our injection fluid, and without color it is impossible to tell when the thorium citrate solution has filled the cavity and is being discharged down the ureter alongside the catheter.

TECHNIQUE OF NITROUS OXIDE ADMINISTRATION IN OBSTETRICS[1]

By A. K. PAINE, M.D., F.A.C.S., Boston

IN view of the increasing interest in measures designed to relieve the severity of pain during labor, this communication is offered in the hope that the practicability of nitrous oxide for this purpose may become more generally known and thereby more widely used.

Recent articles by Heaney, Davis, Lynch, and others have described the use of nitrous oxide during labor, but have perhaps not emphasized the comparatively simple technique of its administration with the consequent availability of this procedure not only in the well-equipped hospital, but in the general practice of obstetrics.

The author's experience with the use of nitrous oxide in obstetrics extends over three or four years, during which time the technique of administration has undergone various changes and modifications until that about to be described seems most satisfactorily to meet the requirements. The earlier work, done in association with Dr. Austin Brant, was with one of the so-called gas-oxygen machines, using the percentages of nitrous oxide and oxygen commonly used in general surgical anæsthesia. With this earlier work an attempt was made to secure a more or less continuous analgesia, but the difficulties attending the maintenance of an even analgesia, together with the mechanical difficulties experienced with the early gas machine, rendered its use not entirely satisfactory. From it, however, certain essential facts concerning the use of nitrous oxide in obstetrics were ascertained. These may be summed up briefly.

The so-called analgesic state secured by the administration of limited amounts of nitrous oxide is sufficient to materially lessen if not to entirely prevent the pain experienced during a uterine contraction.

This analgesic state may be secured so quickly as to make the inhalation of the gas unnecessary until the actual beginning of the contraction. Further, the state continues for an appreciable interval after cessation of gas inhalation, making the actual administration necessary only during a portion of the uterine contraction.

These facts indicate that the amount of gas inhaled is so small and the time of its administration with each pain so short as to obviate the necessity of gas-oxygen admixture to prevent cyanosis.

With the administration of nitrous oxide during uterine contractions, clinically it is observed frequently than an appreciable increase in the duration of the contraction results. A possible explanation of this may be found in the increased carbon dioxide content of the blood ensuing during the administration of nitrous oxide, the former being described as having a specific action in the stimulation of unstriped muscle-fiber.

The use of nitrous oxide in obstetrics is essentially adapted to the period in labor between the beginning of the more severe pains and the time when obstetric ether or general anæsthesia would ordinarily be begun. It is not advanced as a substitute for ether in obstetrics in any sense, but rather is to be used as a means at our disposal to relieve the suffering of labor considerably in advance of the time when the use of ether is wise or practical. When, however, labor is sufficiently advanced to permit of obstetric ether that agent is more advantageously employed than nitrous oxide, allowing a more satisfactory control of the labor than does the gas, the latter with its light and transient anæsthesia not preventing excessive straining, etc. The attempt to secure complete anæsthesia with nitrous oxide and the maintenance of that state, necessitates oxygen admixture with more or less complicated appliances to secure proper proportions and continuous flow, and that with a resulting anæsthesia so light, so easily disturbed as to be maintained with some difficulty in obstetrical work, where changing positions, the nature of the trauma, all combine to upset that delicate balance gas-oxygen anæsthesia demands, thus offering several disadvantages and no marked advantages over ether anæsthesia. The substitution of ether for gas sometime in advance of the actual birth further does away with all problematical effects of the gas on the newborn, as well as the possible increased tendency to hæmorrhage during gas administration.

The administration of nitrous oxide in small amounts during each uterine contraction makes the total amount of gas inhaled during several hours correspondingly small; one of the smaller tanks containing 100 gallons of nitrous oxide being sufficient for four or five hours' administration.

The apparatus necessary for obstetric administration is very simple and together with a small tank (100 gallons containing enough for an ordinary case) weighs not more than 10 pounds,

[1] Read before the Boston Chirurgical Society, November 26, 1915.

adding not impractically to the obstetric outfit to be carried. One hundred gallons of nitrous oxide costs about two dollars, which is indicative that the additional expense of its use in confinements is not prohibitive.

The so-called White inhaler such as is ordinarily used for nitrous-oxide anæsthesia in dental work seems the most satisfactory face-piece. This inhaler has an inlet and outlet valve, the former being removed to allow rebreathing, and an opening and closing device, pressure on which allows gas to enter the face-piece; with release of pressure, the gas is automatically shut off and the patient breathes air. This represents a not unimportant part of the device, for it permits the filling of the bag with gas and its retention until its use, with only escape of the nitrous oxide into the inhaler as it is definitely needed.

To the inhaler two or three feet of non-collapsible five-eighths inch tubing is attached connecting at the other end with the rubber bag which, fully distended, is capable of containing about two gallons of gas; the bag in turn is connected with the gas tank by a length of small tube and the usual connection supplied with the tank. The technique of its use is as follows:

Its administration is begun as soon as the pains are of sufficient severity to warrant an attempt at their relief. Naturally the time varies with different patients and with different labors; approximately it corresponds in the majority of cases to the last half of the first stage, and the first half of the second stage, a period ordinarily productive of perhaps the greatest and most poorly borne pains and yet one not in the majority of cases advantageously managed by the use of obstetric ether. Needless to say the realization by the patient of possible relief at hand, available at any time, in many cases exerts a not unfavorable effect on the manner in which the suffering is borne.

It is well to explain in advance of administration just what is expected of the patient, and of the analgesic, for the patient's co-operation is important in securing the most satisfactory results. Of what this explanation would consist will be obvious as the description of the process follows.

In an interval between pains, gas from the tank is allowed to flow into the bag until it is approximately half full. The actual amount needed in a given case will easily be determined after a few inhalations and that amount may be then let into the bag each time. It has seemed in our experience, however, that a two-gallon bag need rarely be filled, for each pain, more than half full, and frequently a smaller amount is sufficient.

The patient is instructed to state the first consciousness of a beginning pain or that fact is elicited by abdominal palpation, at which time the face-piece is firmly applied and the gas allowed to enter, the patient breathing deeply and rapidly; ordinarily six or seven inspirations are sufficient to produce the analgesic state, and as well to exhaust the gas in the bag; should analgesia not result from this number of inspirations, or should it be apparent that the amount of gas in the bag would not permit of many more inspirations, the outlet valve is held closed with a finger and the patient rebreathes into the bag, two or three such rebreathings being ordinarily sufficient. We have considered this an essential point in technique, to rebreathe two or three times at the end of each administration; this not only reduces materially the total amount of gas consumed, but seems also to hasten the analgesic state with a consequent lessening of the actual time the face-piece is in position. In actual time elapsed about one-half minute is required to secure the fullest analgesia which about corresponds to the maximum intensity of the pain; the analgesia persists for from one-half to one minute after removal of the gas, gradually lessening, corresponding somewhat to the course of the contraction. It is noted that this period of analgesia after cessation of administration depends in length somewhat on the patient's behavior, the attempt or desire of the patient to "come to" materially shortening it, and the importance of relaxation or "giving in" to the effects produced is impressed upon her.

The best evidence of the induction of the state of analgesia apparent to the administrator is the appearance of a very definite relaxation of the patient, breathing deeply and rapidly at first as instructed, with other movements indicative of the beginning pain; the analgesic state is indicated by a cessation of active muscle efforts, the breathing becomes quiet and normal, voluntary movements become less and the patient gives no particular evidence of undergoing severe abdominal pain. This analgesic state is very quickly learned and recognized by the patient herself, and, being reached, she will often remove the face-piece, conscious of no further need for the analgesic. An analgesia carried too far, or into an actual anæsthesia, manifests itself by the appearance of the deep breathing characteristic of gas anæsthesia, perhaps preceded by evidences of a stage of excitement and further indicated by a definite cyanosis. As

Nitrous oxide appliance for obstetric analgesia showing inhaler, bag (partially inflated), and tank connection.

regards cyanosis during gas administration for analgesia in obstetric work, it may be said that in the manner described such administration is not sufficient to produce a definite cyanosis. We have noted a change in color preceding the appearance of actual cyanosis which might be described as a precyanotic pallor, this being a rather typical paleness especially in contrast to the heightened color appearing during the latter part of the analgesia after removal of the face-piece. Actual cyanosis during the obstetric administration of nitrous oxide means to us an error in our technique, generally its continuance longer than necessary to secure analgesia, or delay in securing analgesia due to an ill-fitting face-piece with air admixture resulting, or to too slow breathing, or to definite resistance by the patient.

We have evolved a rule as regards this aspect of gas administration to the effect that should the inhalation of the fairly definite amount of gas prove insufficient to secure analgesia during a given pain we do not attempt to secure it by the addition of more gas or excessive rebreathing, but rather stop its inhalation and with succeeding pains attempt to ascertain the difficulty which is generally one of those mentioned and readily corrected. A not uncommon difficulty experienced at first was the quick passage through the analgesic state to beginning complete anæsthesia from the excessive use of gas when a stage of more or less excitement seemed to indicate that the patient was not getting relief from pain.

With the passing of the analgesic state, the patients not infrequently exhibit a slight degree of cerebral excitement, talking of their sensations, freedom from pain, etc., with more volubility than is ordinarily the case, though after the administration of gas at recurring intervals has gone on for some time that tendency seems to pass.

As regards the effects of long-continued administration of nitrous oxide (five or six hours), in the manner described, it has been impossible clinically to demonstrate ill effects either as regards mother, child, or the course of labor. On the contrary, a definite stimulation of uterine contraction is sufficiently often observed as to make this an apparently to be expected result of the use of nitrous oxide in obstetrics.

AN IMPROVEMENT IN SCREW-HOLDING FORCEPS FOR BONE WORK

By JOHN HUNT SHEPHARD, M.D., Cœur d'Alene, Idaho

THE accompanying illustration shows a forceps which overcomes certain difficulties experienced in holding the screws in plating and also in nailing fractures. The forceps is nine inches long over all. The tip of it is turned up at an angle of forty-five degrees. The point of superiority in this forceps over any other which the writer has used is in the springs, marked *A* in Fig. 1. These springs are inserted on the inner side of the blades, as illustrated in the picture. They are set in grooves and held there by little screws made flush with the blade.

In grasping a screw or nail it is held securely by these springs while at the same time the screw may be turned or a nail may be driven without releasing the grip on the handles of the instrument. The writer has found that with this instrument it is easier to direct the course of the nail or screw than it is with an instrument which has to have the grip released in order to insert the nail or screw into the bone.

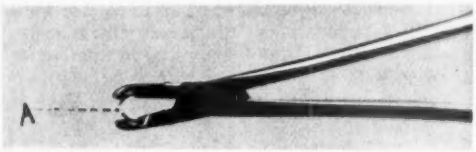

Fig. 1. Forceps open showing spring *A*.

Fig. 2. Forceps closed.

RADICAL AMPUTATION OF THE BREAST UNDER LOCAL ANÆSTHESIA

By HERBERT P. COLE, M.D., F.A.C.S., Mobile, Alabama

RADICAL removal of the breast with complete axillary dissection under local anæsthesia is, in so far as I am aware, a unique procedure in America. In presenting the following technique and case report, I do so giving all credit to Professor Braun of Zwikau as our procedure differed from his in but a minor essential. The readiness with which anæsthesia was accomplished in our case permitting no limitation of dissection, together with absence of operative and post-operative risk, urges my calling the attention of the profession to this method which has been successfully performed in at least twelve operations for amputation of the breast by Professor Braun up to 1914.

Operation, April 17, 1915. The patient, an emaciated woman, 61 years of age, suffered with a rather severe grade of chronic interstitial nephritis. Preliminary administration of scopolamine and morphine was made one hour before, and fifteen minutes before operation. The anæsthesia was produced in three stages:

1. The brachial plexus was first injected after the method of Kulenkampf, a small wheal being made over the middle of the left clavicle at its upper border, the patient in a sitting position, a needle 5 cm. in length was directed inward and downward toward the spinous process of the third dorsal vertebra to a depth of 2 cm. The patient complained of parasthesia over the distribution of median and radial nerves. There being no flow of blood from the needle, 10 ccm. of a 2 per cent novocaine-adrenalin solution was injected, the needle being forced slightly deeper during the last of the injection. An additional 10 ccm. of a 1.5 per cent solution was distributed in the immediate surroundings. Complete sensory and motor paralysis of the arm was present in from 3 to 4 minutes.

2. After the method described by Kappis, paravertebral conduction anæsthesia was obtained by infiltrating around the first to eighth dorsal nerves, using 5 ccm. of a 1 per cent novocaine-adrenalin solution at points 3.5 cm. from the median line, at a depth of from 4 to 5 cm. feeling the rib or transverse process. The point of the needle was then directed past the lower border of the bone from 1 to 2 cm. deeper and toward the median line at an angle

Fig. 1. X marks point of brachial plexus injection. Solid line marks infiltration blocking supraclavicular branches. Dotted line marks blocking of overlapping innervation of sternum. NOTE.-We have not blocked below breast as advocated by Braun.

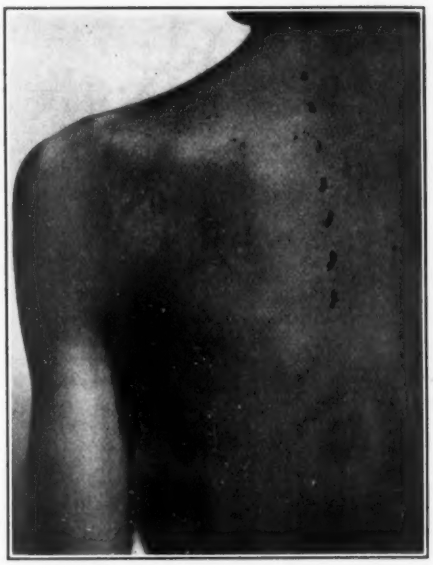

Fig. 2. Note points of injection for paravertebral conduction anæsthesia.

of from 20 to 30 degrees. Five ccm. of a 10 per cent solution of novocaine-adrenalin solution was then injected about each nerve.

3. Finally, 90 ccm. of a 0.5 per cent novocaine-adrenalin solution was injected subcutaneously along the clavicle and down the inner border of the sternum blocking off the supraclavicular branches and overlapping the innervation from the opposite side of the sternum. We made no injection of the tissues below the level of the breast. In this particular we differed from the method employed by Braun. The time required for these injections was about twenty minutes and produced absolute anæsthesia permitting a very extensive dissection, over an hour and forty-five minutes. A Jackson incision was made, both pectoral muscles removed, and the axilla carefully dissected. The Jackson incision permitted closing without grafting axillary drainage. The patient was entirely conscious throughout the operation and complained of no pain.

Post-operative. The patient returned to the ward with a pulse of 78, was placed in a sitting position and then given her breakfast. There was no post-operative nausea or vomiting. There were no urinary changes, and she was on general diet without missing a meal during her hospital residence. Discharged in 10 days.

Pathological examination. Adenocarcinoma of the breast with axillary involvement.

CONCLUSION

The ease and safety with which this anæsthesia may be produced, without risk of entering the carcinoma field with the needle, warrants its application in cases suffering from cardiac, pulmonary, or renal complications.

BOOK REVIEWS

A CRITIQUE OF NEW BOOKS IN SURGERY

By MAJOR G. SEELIG, St. Louis

IF one were to tabulate all the possible perfunctory tasks in the world of acts, he would probably find that the one most perfunctorily done is the average medical book review. The reasons for this are very patent and require neither discussion nor explanation. The intelligent reviewer should, of course, experience no difficulty in steering clear of the slovenly formalism which is the tap-root of perfunctory reviewing. His problem, and by no means is it an easy one, is the cultivation of a judicial attitude of mind; nor will it suffice merely to be a judge— he should always temper judgment with mercy. How simple for the reviewer, with the last word always at his command and his identity usually concealed by anonymity or by initials, to arrogate to himself the right to hoist the colors for "No Quarter Given" and proceed to "slam" a book until he has repulpified it and its author. On the other hand, how difficult it is to cultivate the tendency to try to read into a volume that which the author hoped to put into it, to be generous yet discriminating in bestowing praise, guarded yet sure in picking flaws, broad yet firm in balancing the good against the bad.

These thoughts were called into being by an editorial in a recent issue of the literary supplement of *The New York Times*. The editor tells a story of an ignorant village barber, who considered himself pre-eminently fitted to be a dramatic critic, because he had endowed himself with an imaginary innate ability to see faults in dramatic productions, where others saw virtues. The editorial goes on to say, "Like our barber, every one who can pick faults in a book, or who can substitute his own theory for that of its author, imagines himself, for that reason, a competent book reviewer." Then there follows a paragraph which should be hand initialed, illumined, framed under glass, and hung just above the desk of every reviewer—literary or medical: "A fair and appreciative estimate of a book, one that indicates, without detraction, the author's purpose and achievement is of positive value to the public and just to the literary work under consideration. The old-fashioned review that is witty at the expense of the author, or that annihilates the latter with sledge-hammer blows to the infinite satisfaction of the executioner, if not to his victim, is rapidly growing in disrepute. A stricter sense of justice demands that a fair field should be shown an author, an exact estimate of his book furnished a reading public that, in this connection, may be in the attitude of a prospective buyer. The informative rather than the purely critical review, the review guided by personal opinion, becomes thus the most useful to the latter. Impartiality is better worth cultivating as a practical asset in the rendering of literary judgment than stark censoriousness. After all, Bacon's famous rule holds for reviewers equally with readers of books: 'Read not to contradict or to confute; not to believe and take for granted; but to weigh and consider.' "

Even if this bit of editorial wisdom had escaped my eye, the books of the month would themselves have served to stimulate the thoughts already expressed; for among them are two volumes which, if viewed narrowly, might inspire a spirit of unfair disagreement and call forth double-edged phrases of stiletto keenness.

Take for example this newest volume by Crile on *A Mechanistic View of War and Peace*.[1] I might have summarized the volume by saying that it is small, handy, and attractive, and that in six chapters it attempts to expound the thesis that war is brewed by formula not totally unlike the mathematical formula governing the angles of incidence and reflection. This thesis is stated in a short introductory chapter. The second chapter, I might have explained, deals with "The Phenomena of War" and expounds such shibboleths as, "Integration of the Community" and "Kinetic System," together with such more material phenomena as artillery fire, trench fighting, the charge, retreat, fatigue, pain, courage, loss of sleep, wounds, and causes of death. chapter iii, I might have gone on to add, is devoted to the very commonplace deduction that man has risen through the innumerable ages by struggle, and that present day war is the evolutionary vestigial evidence of former almost constant battling. Chapter iv, "A Mechanistic View of German Kultur," I might have characterized as a bold attempt to explain the working of German *kultur* on the basis of its analogy to the ant colony (Crile says these two types of *kultur* are identical), and then I might have pointed out smugly the cleverness with which Crile cuts the Gordian knot; for while other astute minds are painfully laboring to show that German *kultur* is the mark of either the superman or the devil, Crile clearly shows that the lowly ant is the typical representative. Then I might

[1] A Mechanistic View of War and Peace. By George W. Crile, M.D. New York: The Macmillan Company, 1915.

continue the analysis with tender sarcasm and say that chapter v, "A Mechanistic View of the Vivisection of Belgium," proves that the reason why Liege and Namur had to be blown up was because the brain, liver, adrenals, and thyroids of the Belgians yielded under the strain of emotional excitement; and finally I might have concluded with the statement that the closing chapter on "Evolution Toward Peace" is based on the astounding statement that the mechanistic doctrine "fixes all responsibility for human action here and now, within oneself."

I say advisedly, *I might have done* all this. I am an avowed — though qualified — antimechanist and I might, very conceivably, in antimechanistic heat, have set about deliberately to shatter what impressed me as a weak argument. But in so doing I should have disregarded Dr. Crile's own modest disclaimer of any "special knowledge of philosophy or psychology," I should have slurred over the essential ingenuity involved in the admirably keen analysis of the behavior of man under the actual stress of war, Crile's unique fitness to correlate the laboratory and the ward, and his pervasively insinuating personality. Finally, I should have fallen inestimably far short in failing to point out the significance to surgery, of a man who, in the language of Claude Bernard, clothes himself in his imagination. Indeed, I should have had a debit account of so many sins of omission that I should have been ashamed to father the review. How much better and saner to recognize all these excellencies and to recommend the book as a stimulating volume!

AFTER one has spent about three solid evenings in going through this mammoth volume of Brophy's on *Oral Surgery*,[1] carefully noting on fly leaves and margins the deficiencies and points of excellence, he comes to the conclusion that in this instance also it would be easy to play the part of the village barber and point out with autocratic acumen how the task of the author could have been better performed. For instance, there is a strong overemphasis of surgical principles, even considering the book as a *vade mecum* for dentists (fractures of the long bones are dragged into the text literally by the scruff of the neck). Not infrequently symptoms are inadequately described, as in the various diseases of the tongue, and operative treatment not clearly expounded, as in that portion devoted to mandibular ankylosis. If one desires specific information regarding the diagnosis and treatment of the interesting group of giant-cell sarcoma of the lower jaw, he will find his desire far from gratified.

On the other hand, if one stops to think of Dr. Brophy as the practical founder and militant exponent and champion of oral surgery in the United States, and if one considers how much we general surgeons owe him on that score, and if one then further considers that the volume is not only the product of an unusually ripe clinical experience but also is the result of twenty-five years of planning, the thought is driven home that these things constitute the spirit of the work. With this point of view, caviling criticism has no place and only hearty praise finds expression.

The book is eleven hundred pages thick, and by its very bulk defies detailed criticism. Nearly one-fourth of the work is devoted to surgical principles: surgical bacteriology, special infections, syphilis, tuberculosis, immunity, tumors, wounds, asepsis, etc. There is an excellent chapter on the surgical engine by Dr. M. H. Cryer — a chapter that would be of more universal interest to surgeons, were it not for the latter-day development of the more compact electric motors. Following this chapter, there are discussed in order the following subjects: Infections of oral origin; the tongue, tonsils, and adenoids; embryology, anatomy, and physiology of the mouth; fractures of the bones of the face; dislocation of the mandible; diseases of the mouth; ankylosis of the temporomaxillary articulation; antrum of Highmore; harelip; cleft palate; the training of speech after cleft-palate operations; plastic surgery; dento-alveolitis, extraction of teeth, transplantation of teeth; cysts; maxillary and mandibular tumors; trigeminal neuralgia; the salivary glands; eugenics; prosthesis; infant feeding; ligature of arteries (carotids, lingual, facial, temporal, coronary); prognathism; diseases of the lips.

For those of us who have followed Dr. Brophy's writings on harelip and cleft palate, not the least valuable attribute of the work lies in the concrete presentation of his views between two covers. The greatest value of the book lies in the indispensable part it plays in rounding out that portion of the library devoted to oral surgery.

IT has not been so very long ago that we commented on the appearance of a large number of excellent treatises on operative surgery. We had in mind at that time the reservation that our preference for our *Jacobson* was still largely unqualified. Now that a new up-to-date revision has appeared, we stand the two new volumes[2] shoulder to shoulder with even bulkier and more pretentious systems of operative surgery. Unfortunately, Mr. Jacobson himself took no part in the revision of the sixth edition, and yet one must admit that the work of Messrs. Rowlands and Turner has been so well done that one scarcely misses the author's guiding hand.

Regarding format, very little is to be added to our comments on the preceding edition. Each of the two volumes has been increased very appreciably in size, and the arrangement has been altered so as to

[1] Oral Surgery: A Treatise on the Diseases, Injuries, and Malformations of the Mouth and Associated Parts. By Truman W. Brophy, M.D., D.D.S., LL.D. With Special Chapters by M. H. Cryer, M.D., G. H. Makuen, M.D., W. J. Younger, M.D., F. W. Belknap, M.D., C. S. Case, M.D., D.D.S. Philadelphia: P. Blakiston's Son & Co., 1915.

[2] The Operations of Surgery (Jacobson). Sixth Edition by R. P. Rowlands, M.S., F.R.C.S., and Philip Turner, B.Sc., M.S., F.R.C.S. New York: The Macmillan Company, 1915.

reserve the second volume exclusively for abdominal surgery. Volume I is devoted to the head, neck, spine, thorax, upper and lower extremity. The old order of careful, almost didactic consideration of indications, contra-indications, dangers, and results is preserved, and it constitutes not the least part of the large value of the work. Indeed this, with the strong personal tone that pervades every page places the work in a class by itself. In the first volume, I have looked in vain for statements to which one might take specific exception, such as might be characterized as dissent. It is impossible, of course, to note seriatim the various descriptions. One misses, with some surprise, a discussion of any of the newer operations for arthroplasty, and with equal surprise notes the absence of discussion of alcohol injections for trigeminal neuralgia. The general principles underlying the formation of good weight-bearing amputation stumps, and the detailed post-operative care of stumps are not accorded the space and attention that is warranted by the newer literature on this subject. In reading through the chapters devoted to chest surgery, one gains the very definite impression that the editors do not fully appreciate the scope and value of intratracheal anæsthesia. The method is described accurately, it is true, but it is not recommended in most of the operations on the mouth, pharynx, and air passages.

Volume II deals with hernia, peritonitis, gastrotomy and gastrostomy after much the method as was followed in the preceding edition. One notes, merely in passing, that the editors have adopted the inguinal route operation for femoral hernia as the rational procedure. The next chapters on the surgery of gastric and duodenal ulcer are classical condensations of the very best opinions of the day. One almost feels tempted to say that every surgeon should set, as a self-imposed task, the reading of these chapters. Intestinal surgery is handled next, and one finds here, in chapter xxii, a full exposition of intestinal stasis. We feel that too much space has been devoted to this subject (forty pages) when we consider that practically all of the subject matter is quoted literally from Lane's work and introduced by the editors with the laconic sentence, "Time will prove whether these views are right or not." The chapter on splenectomy is interesting in that, although splenectomy is recommended in Banti's disease and splenic anæmia, no mention is made of it as a therapeutic procedure in pernicious anæmia or hæmolytic icterus. It is difficult to determine, however, whether the authors might not intend to include hæmolytic icterus under the generic term of splenic anæmia. The chapter devoted to the rectum is particularly well done, the editors showing the uncommonly good judgment, for instance, of incorporating Miles' description of the combined operation for cancer of the rectum.

A large sale of a work such as this can only work for the ultimate good of surgery.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

THE ROENTGEN DIAGNOSIS OF SURGICAL LESIONS OF THE GASTRO-INTESTINAL TRACT. By Arial W. George, M.D., and Ralph D. Leonard, A.B., M.D. Boston: The Colonial Medical Press, 1915.

THE AMERICAN ILLUSTRATED MEDICAL DICTIONARY. Eighth edition. By W. A. Newman Dorland, A.M., M.D., F.A.C.S. Philadelphia and London: W. B. Saunders Company, 1915.

AN INTRODUCTION TO BACTERIOLOGY FOR NURSES. By Harry W. Carey, A.B., M.D. Philadelphia: F. A. Davis Company, 1915.

THE MEDICAL CLINICS OF CHICAGO. November, 1915. Philadelphia and London: W. B. Saunders Company, 1915.

LIPPINCOTT'S NEW MEDICAL DICTIONARY. THIRD EDITION. By Henry W. Cattell, A.M., M.D. Philadelphia and London: J. B. Lippincott Company, 1913.

THEORY AND PRACTICE OF BLOODLETTING. By Heinrich Stern, M.D., LL.D. New York: Rebman Company, 1915.

HOSPITALS AND THE LAW. By Edwin Valentine Mitchell, LL.D. New York: Rebman Company, 1915.

THE OBSTETRICAL QUIZ FOR NURSES. A MONOGRAPH ON OBSTETRICS FOR THE GRADUATE AND THE UNDERGRADUATE NURSE IN THE LYING-IN ROOM. By Hilda Elizabeth Carlson. New York: Rebman Company, 1915.

YOUR BABY; A GUIDE TO MOTHERS. By E. B. Lowry, M.D. Chicago: Forbes & Company, 1915.

COLON HYGIENE. By J. H. Kellogg, M.D., LL.D. Battle Creek, Michigan: Good Health Publishing Company, 1915.

ENCYCLOPEDIA MEDICA. Second edition. Under general editorship of J. W. Ballantyne, M.D., C.M., F.R.C.P.E. Vols. I and II. New York: The Macmillan Company, 1915.

SPEAKING OF OPERATIONS. By Irvin S. Cobb. New York: George H. Doran Company, 1915.

Clinical Congress of Surgeons of North America

SEVENTH ANNUAL SESSION

PHILADELPHIA

OCTOBER 23 TO 28, 1916

CLINICAL CONGRESS OF SURGEONS OF NORTH AMERICA

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PLANS FOR THE PHILADELPHIA MEETING

UNDER the leadership of Dr. Robert G. LeConte as Chairman of the Committee on Arrangements, the clinicians of Philadelphia are working out plans for the seventh session of the Congress to be held in Philadelphia the week of October 23, 1916. It may be confidently assumed at the beginning that Philadelphia with its numerous large hospitals and well organized clinical facilities will be able to provide a program of unusual interest. Those members of the Congress who were privileged to attend the second session held in Philadelphia in November, 1911, will recall with great pleasure the splendid program of clinics offered by the Philadelphia surgeons at that time and will look forward with interest to a second opportunity of visiting that city. Before the next issue of this journal goes to press it is expected the work of the committee will have progressed so that a preliminary schedule of clinics and demonstrations may be published, together with the personnel of the committee on arrangements.

The Executive Committee of the Congress is in a position to make the following announcement as regards the general plans for the next meeting: Headquarters will be established at the Bellevue-Stratford where the Ballroom, Clover Room, Red Room, Green Room, and adjacent foyers and smaller rooms have been reserved for the use of the Congress. These rooms are located on the second floor of the hotel and provide ample space for registration and ticket bureaus, bulletin boards, etc., the Ballroom being used for the evening meetings. A large number of members can be accommodated at this hotel, while other first-class hotels, located within two or three blocks of headquarters, can accommodate the remainder of the members.

In accordance with the precedent established at the meeting in London in 1914 and carried out at the Boston session in October, 1915, attendance at this session will be limited in number. A careful survey of the operating amphitheaters, lecture rooms, and laboratories in the hospitals and medical schools, as to their capacity for accommodating visiting surgeons, will be made and the limit of attendance will be based thereon. This plan insures accommodations at the clinics for each one who receives a membership card. In addition attendance at all clinics and demonstrations will be controlled by means of special tickets, the number of tickets issued for any clinic being limited to the ascertained capacity of the room in which the clinic is given.

Later in the year a formal announcement of the plans for the Philadelphia session together with an invitation will be sent to all members of the Congress and advance registrations will then be accepted in the order of their receipt up to the limit of attendance which will be fixed. The

popularity of these clinical meetings has become so great that this plan of limiting the attendance and requiring advance registration, which has worked so satisfactorily at the two previous sessions, has been adopted as a rule for all succeeding sessions of the Congress.

The general plan of the Congress will include clinical demonstrations, operative and non-operative, in every department of surgery, including gynecology, obstetrics, genito-urinary surgery, orthopedics, roentgenology, surgery of the eye, ear, nose, and throat, surgical pathology, etc. The clinical demonstrations at the hospitals and medical schools will occupy the hours from 9 to 5 of each day, while the evenings will be devoted to sessions at which eminent surgeons will read and discuss papers dealing with subjects of present-day interest.

There are no annual dues for members of the Congress. The constitution provides that a registration fee shall be required of each member attending an annual meeting. These fees provide the funds to meet the expenses of preparing for and conducting the annual meetings, so that no financial burden will be imposed upon the profession in the city entertaining the Congress.